NATIONALGEOGRAPHIC.COM/MAGAZINE JUNE 2005

NATIONAL GEOGRAPHIC

THE NEW FACE OF King Tut

HIS LIFE AND DEATH

EUROPE IN TRANSITION

RESHAPING A CONTINENT

The titans of European history—from Charlemagne to Napoleon—fought to unite Europe by the sword and gun. Not until after the horrors of World War II did leaders try to unify the continent without bloodshed. Hoping to secure peace by linking their economies and governments, Western European leaders in 1951 created the precursor to today's European Union. What started as a small, six-nation alliance has grown, with its enlargement last year, to include almost all of western and central Europe. "The first of May 2004 will go down in history as the day of the continent's unification; when Europe's decades-long divide was healed; when a dream was realized," declared then European Commission President Romano Prodi in a speech after the unprecedented expansion.

Now a sprawling conglomerate, the EU operates in 20 official languages and includes some of the world's most affluent cities as well as impoverished rural pockets. Switzerland, Norway, and Iceland have not joined; Romania, Bulgaria, and Croatia are expected to enter in a few years, and Turkey officially begins membership negotiations this fall. With such vast divides in resources and cultures, one question predominates: What does it mean to be European?

1920 Post-World War I

Empires to Nations

World War I erupted in 1914 between the Central Powers—Germany, the Ottoman Empire, Austria-Hungary, and Bulgaria—and the Allied Powers, including France, the U.K., Russia, Italy, Japan, and later the U.S. Words of 19th-century novelist Honoré de Balzac once again rang true: Europe's feet were "dipped in blood to the ankle." The war left roughly ten million people dead and Europe in economic shambles. Old empires crumbled, and new nations emerged. In 1919 the Treaty of Versailles created the League of Nations to mediate hostilities between countries. It forced Germany to claim responsibility for the war and pay reparations. Few imagined that the seeds of another war were being planted.

Empires
- Austria-Hungary until 1918
- German Empire until 1918
- Ottoman Empire until 1923
- Russian Empire until 1917
- Other country

Governments
- Communist
- Monarchy
- Republic

Cities with more than one million people shown

Founded in the wake of three successful wars, the German Empire lasted from 1871 until its demise in 1918.

The Russian Empire lost vast territories in World War I, including Finland and Poland. The Baltic republics of Estonia, Latvia, and Lithuania enjoyed brief independence but were eventually absorbed into the Soviet Union.

In 1918 Austria-Hungary came to an end, with it the almost 500-year-old empire of the Habsburgs.

Defeated by the Allies, the Ottoman Empire, which included most of northern Africa, collapsed by 1923 after reigning for more than six centuries.

1960 Post-World War II

Europe Divided

Believing that Europe would rather appease Germany than face a new war, Hitler remilitarized his country and reclaimed territory. After he invaded Poland in 1939, Britain and its allies fought back. The war ultimately claimed some 50 million lives worldwide. After Germany's surrender in 1945, the alliance between the U.S., U.K., and Soviet Union crumbled. "An iron curtain has descended across the continent," British Prime Minister Winston Churchill famously declared in 1946. As the Soviets tried to draw the curtain west, the Cold War between the U.S. and U.S.S.R. began, with the threat of nuclear war at its core. Each side created a military alliance—NATO and the Warsaw Pact. Then in 1961, Soviet-backed East Germany built a wall splitting Berlin, symbolically dividing a country and a continent.

Military Alliances
- Warsaw Pact country
- NATO country
- Neutral country
- Iron Curtain

Economic Alliances
- European Economic Community
- European Free Trade Association

Governments
- Communist
- Monarchy
- Republic

Cities with more than one million people shown

To enforce communism during the Cold War, Soviet troops invaded East Germany in 1953, Hungary in 1956, and Czechoslovakia in 1968.

To counterbalance the Soviet armies positioned in eastern and central Europe after World War II, 12 Western nations established a military alliance—the North Atlantic Treaty Organization—in 1949.

In 1957 six nations formed a free trade zone by creating the European Economic Community (EEC). Nations excluded from the group made their own alliance—the European Free Trade Association—in 1960. The EEC later became the nucleus of the EU.

2005 Post-Cold War

Toward One Europe

Under Soviet leader Mikhail Gorbachev the Cold War ended, marked by the demise of the Berlin Wall in 1989 and of the Soviet Union in 1991. Communism's collapse freed countries like Poland and Hungary from Soviet domination. It also brought a resurgence in nationalism and ethnic tensions, which tore apart Yugoslavia. The European Union grew to 15 members in 1995 and later introduced a shared currency—the euro—which 12 EU countries now use. Though traditional powerhouses, notably France and Germany, still wield the greatest clout, the EU has created its first constitution, which must be unanimously ratified by all 25 member nations. After 60 years of relative peace, Europe may be realizing its dream of stability.

European Union
- Member
- New member in 2004
- Applicant
- Neither member nor applicant

Governments
- Monarchy
- Republic
- Migration to Europe

Cities with more than one million people shown

Norway, Iceland, and Switzerland have chosen to remain out of the EU mainly to protect their independence and wealth. To do business with the EU, they must comply with many EU regulations. To gain a vote on such matters, they may join in the future.

Germany is home to the largest Turkish diaspora: Two million ethnic Turks—who first arrived in large numbers as guest workers in the 1960s—now live in Germany.

One of the fundamental rights of EU citizens is to move freely within the union. However, workers in the ten new member states still face restrictions in some of the older EU countries.

In Northern Ireland the 1998 Belfast Agreement promised peace between loyalists who want to remain under British rule and republicans who favor a united Ireland. Continued violence by paramilitary groups on both sides stands in the way of resolving the decades-old conflict.

France, which has the largest Muslim and Jewish populations in western Europe, banned "overt" religious symbols—including Islamic head scarves—in schools last year.

The terrorist group ETA continues to set off bombs in its campaign for an independent Basque homeland straddling Spain and France. Since 1968 the group has killed more than 800 people.

The 2.5 million ethnic Hungarians living in neighboring countries struggle to maintain their cultural ties with Hungary.

Rampant poverty, unemployment, and discrimination plague the 8 to 12 million Roma, or Gypsies, across the continent. Large numbers live in central and eastern Europe.

Separatist groups on the French island of Corsica began a struggle for autonomy in the 1960s and soon turned to violent tactics, which continue today.

Of the five former Yugoslav republics, Slovenia is the only EU member so far. The UN still administers the province of Kosovo in Serbia and Montenegro due to continuing tensions between Kosovo's Albanian majority and Serb minority. The conflict hinders Serbia and Montenegro's chances of joining the EU.

The mainly Slavic-speaking Transdniestria region of Moldova declared itself a separate republic in 1990, preferring to be allied with Russia rather than with Romanian-speaking Moldova. Russian troops in the region have solidified the secessionists' control.

The Russian republic of Chechnya has been fighting a brutal battle for independence against the Russian military since 1994. Upwards of 100,000 people have died in the struggle.

Almost half of the 470,000 immigrants who arrived in Spain in 2003 came from the Americas, the largest number from Ecuador.

Spanish authorities believe that Islamist militants linked to al Qaeda are responsible for the March 11 train bombings in March 2004 that killed 191 people. The attacks led to the establishment of a counterterrorism "czar" to coordinate security efforts across the EU.

Britain has ruled Gibraltar for 200 years; Spain still wants it back. The two nations have discussed sharing sovereignty over the territory, but with aspirations of self-rule, Gibraltarians oppose the plan.

Thousands of illegal immigrants have died trying to cross from North Africa to Europe in the past decade. Many children make the trip on their own. Almost 3,000 have found refuge in France alone.

Because of its location, the Italian island of Lampedusa is a popular entry point into Europe for illegal immigrants from Africa, the Middle East, and Asia.

In the Aegean, disputes still smolder between Greece and Turkey over territorial waters, airspace, and potential oil and gas exploration on the seafloor.

The Greek side of Cyprus joined the EU in May 2004 after efforts to unify the Greek and Turkish sections failed. Turkey's recent willingness to hammer out a compromise over its troubled relationship with Cyprus opened the door for Turkey's EU membership negotiations to begin.

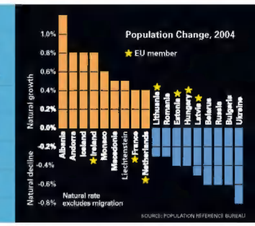
The EU has made protecting the civil and human rights of minorities a core tenet of membership. Turkey has made progress in its treatment of prisoners and its relations with ethnic Kurds, but it will likely take a decade for Turkey to meet all membership criteria.

Asia is the largest source of immigrants residing in the boundaries of Europe itself. Some 706,000 adult Chinese live in Italy today, up from 14,000 a decade ago.

The Human Current

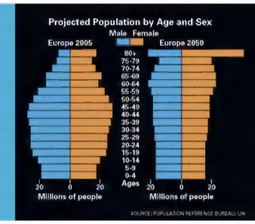
BABY BUST

Europe's population is steadily shrinking, the only major region of the world expected to face decline. Because of low birthrates, its numbers are projected to drop from 728 million in 2005 to 652 million by 2050. Some countries did have more births than deaths and gained population in 2004, such as Albania and Ireland. But the long-term trend is dire. Statistically, to keep a population at replacement level, countries need a fertility rate of 2.1 babies born per couple. Overall Europe's fertility rate has dropped to an alarming 1.4. For decades France and Sweden have offered generous family benefits in hopes of creating a baby boom, with modest success. Russia's dilemma is especially troubling: Not only is its fertility rate low, but life expectancy has also been falling.



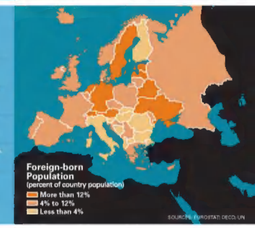
A GRAYING LAND

With Europeans having fewer babies and generally living longer, the population is getting older. Infants born today will live eight years longer on average than those born in 1950. An aging society means fewer workers will support more retirees, with pensions and healthcare costs soaring. "This development will affect almost every aspect of our lives," says Vladimír Špidla, a European commissioner. "It is time to act now." To maintain sizable workforces, governments will need to raise retirement ages and recruit more foreigners. But immigration alone cannot stem the tide. Germany, for instance, would have to welcome a staggering 3.8 million immigrants each year to offset its declining population.



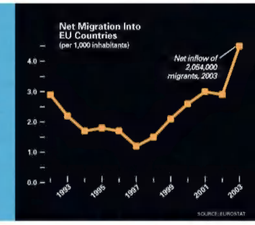
DESTINATION EUROPE

Europe is now a top draw for foreigners seeking better lives. Between 1960 and 2000 Europe's foreign-born population (excluding the former U.S.S.R.) rose from 14 million to 33 million. Turks and North Africans often migrate to wealthy countries like Germany and the Netherlands, while many ethnic Russians remain in former Soviet nations. As home base for some EU institutions, Luxembourg has a population that is 40 percent foreign-born, most from other EU nations. Though they ease labor shortages, new arrivals have increased anxieties over cultural identities and values. Austria can fine and expel immigrants who fail to attend a mandated German-language course, and Britain will require immigrants seeking citizenship to pass a test.



MIGRATION ROLLER COASTER

The number of immigrants in Europe skyrocketed in the early 1990s as the Soviet Union and Yugoslavia collapsed. Beginning in 1993 many western European countries tightened immigration controls. Then as the European economy strengthened in the late 1990s, immigration numbers started rising again. Today Spain, Italy, the U.K., and Germany receive some 80 percent of the net inflow of immigrants in the EU.



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Consultants: Hans-J. de Bij, Michigan State University; Carl Haub, Population Reference Bureau

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NATIONAL GEOGRAPHIC

Europe

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ALLEN CARROLL, CHIEF CARTOGRAPHER

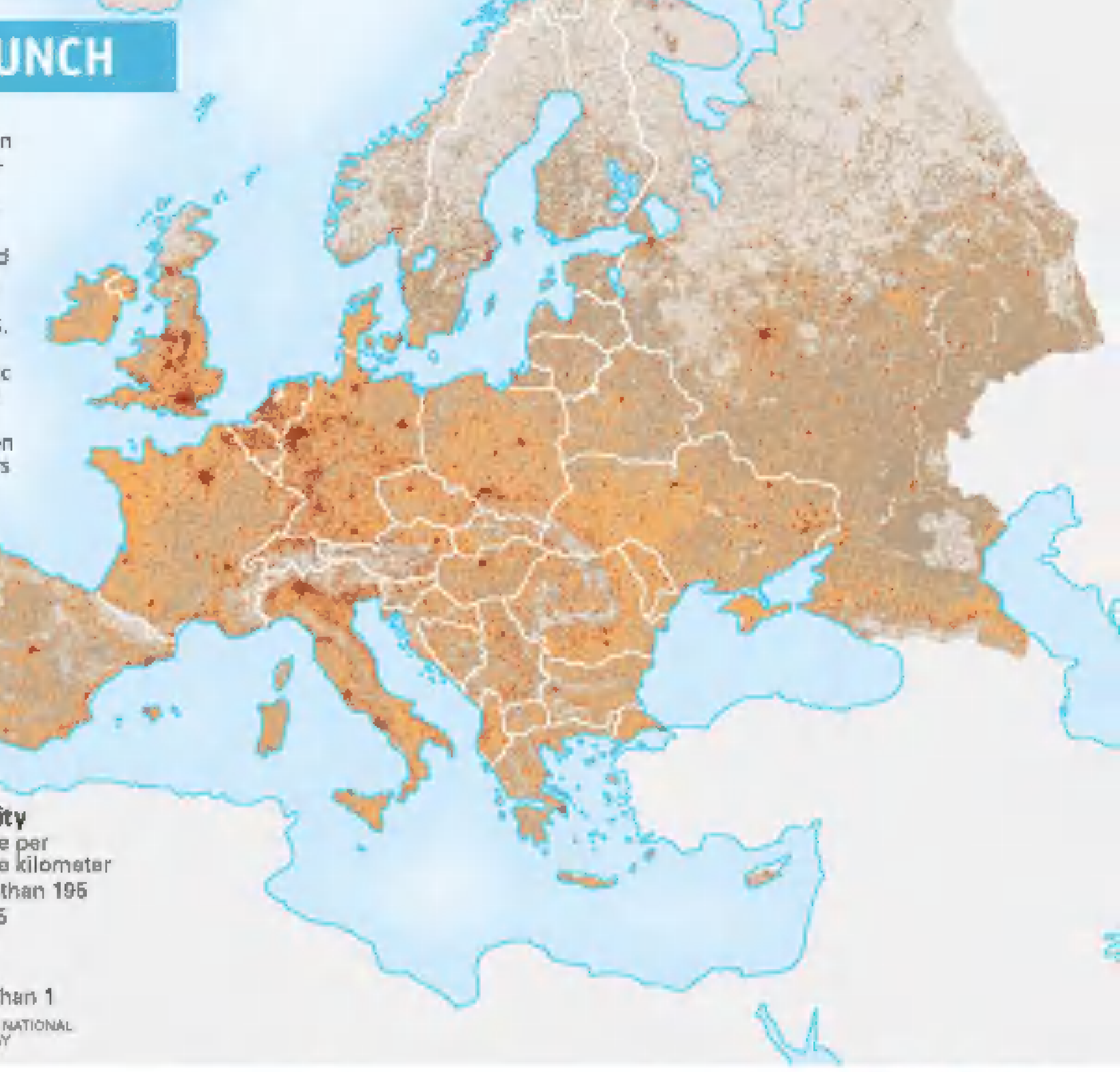
Washington, D.C., June 2005

Through a purely geographic lens, Europe ambles from Iceland to Greece to Russia's Ural Mountains, with Moscow well within its bounds. But at its soul, Europe is more a concept than a continent—a political idea increasingly shaped by the European Union. Today that partnership embraces landscapes and cultures that are more disparate than at any time in its history. The EU's motto: *in varietate concordia*, united in diversity.

In May 2004 the EU admitted ten countries, including eight former communist nations, a historic expansion that formed a 25-member bloc with 457 million people. Several more countries are clamoring to join. The appeal? As part of a single-market economy, EU members tend to gain wealth, stability, and political clout. But rapid expansion has raised tensions over ethnic, religious, and cultural identity, leading some to fear that more growth will dilute the EU's newfound strength—and the idea of Europe itself.

NUMBER CRUNCH

Drive in Paris at rush hour and you'll sense the strain on Europe's cities. Nearly three-quarters of the continent's 728 million people now live in urban areas. Because development is concentrated around historic urban cores, European cities have less sprawl than those in the U.S. and are far more densely packed, groaning with traffic and pollution. To combat its traffic problems, London is charging drivers a congestion tax of more than nine dollars to travel in the city center during business hours—a move other cities plan to follow.

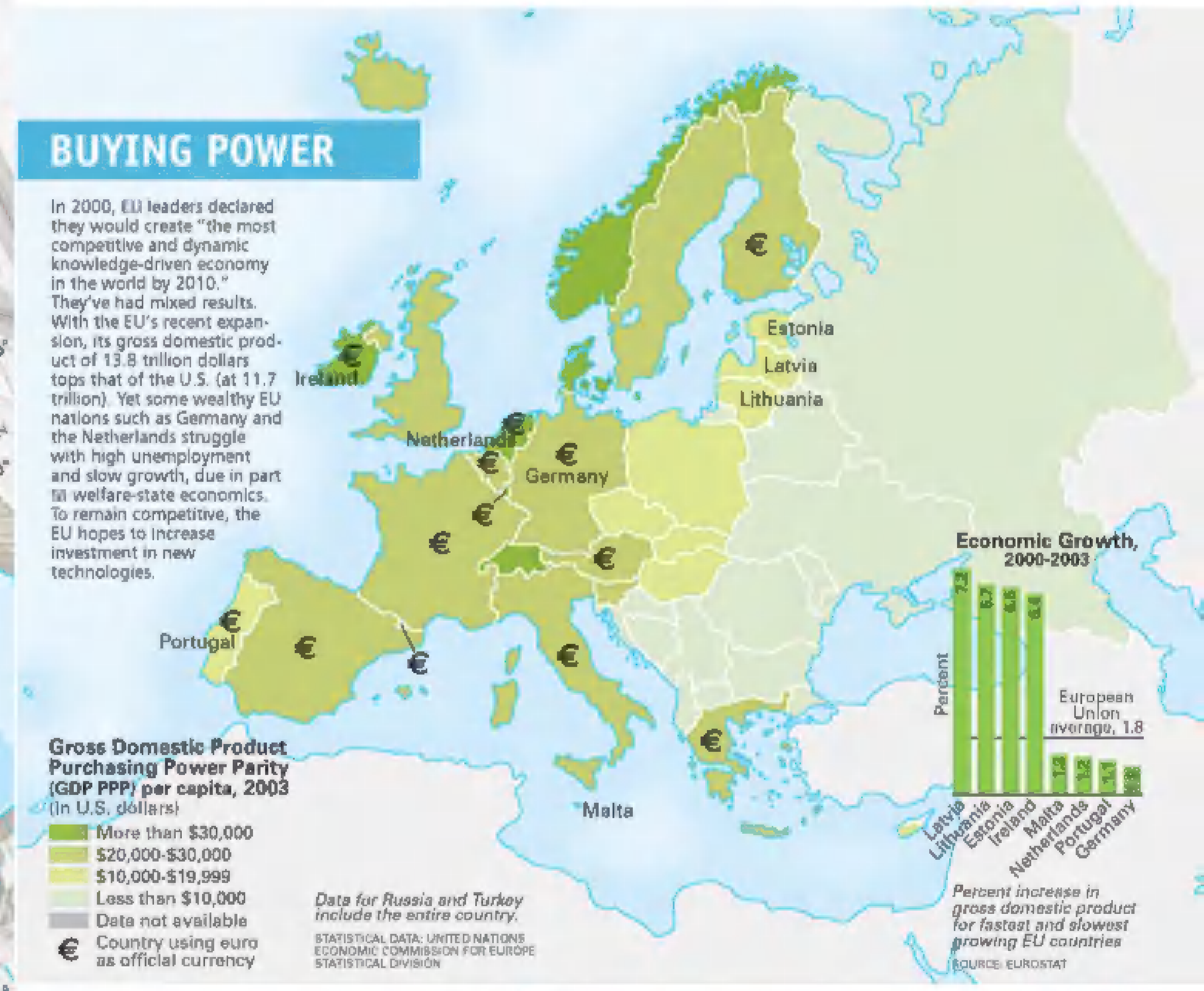


MOTHER TONGUES

A war of words simmers in Europe today, home to some 230 indigenous languages. Almost half of all Europeans now speak English, which has surpassed French as the language of diplomacy in the EU, a trend decried by France. Earlier this year, Spain and Italy launched protests after the EU began using only English, French, and German in some news conferences. Language equality comes with a cost: The EU spends more than one billion dollars a year to translate documents into its 20 official languages.

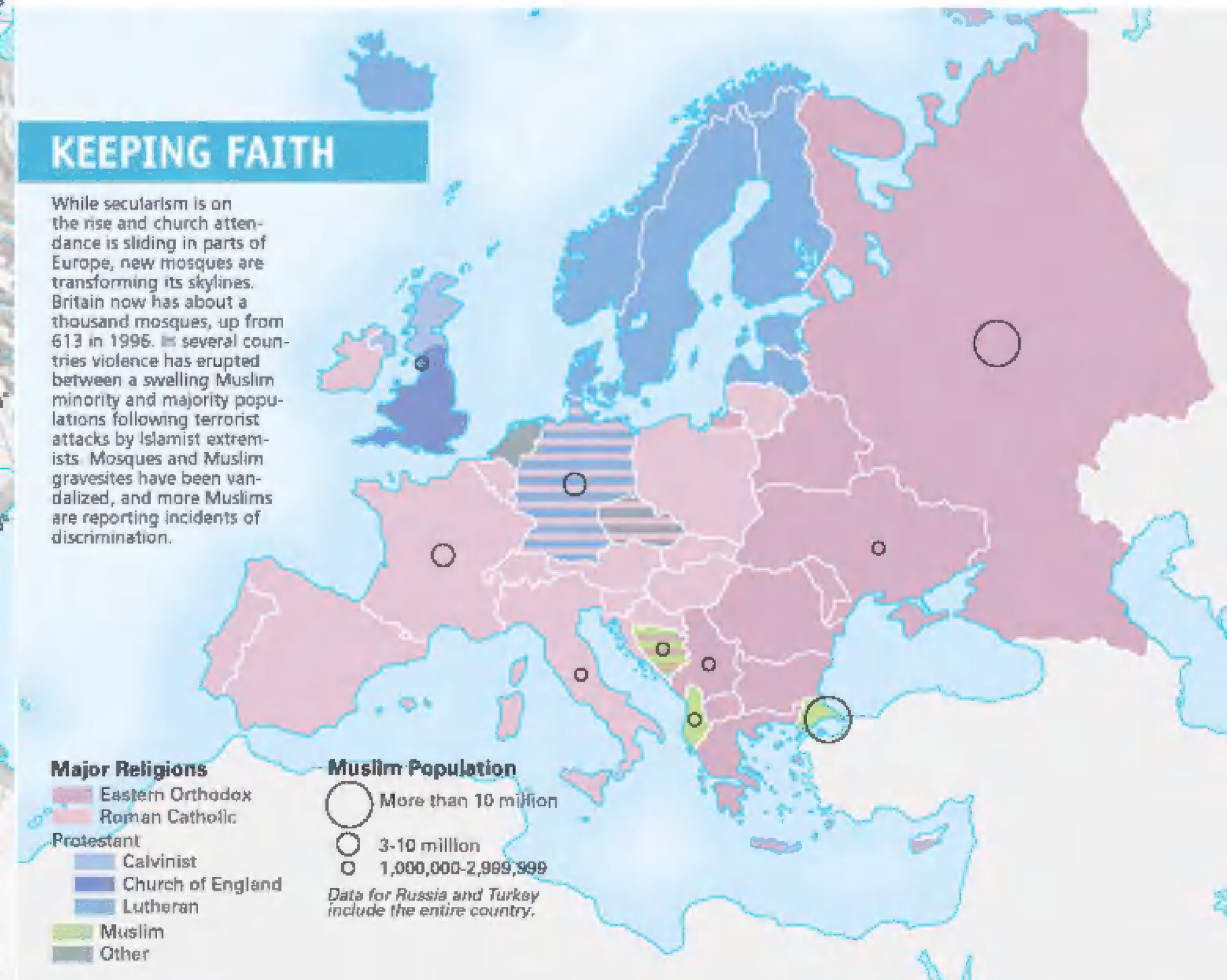
BUYING POWER

In 2000, EU leaders declared they would create "the most competitive and dynamic knowledge-driven economy in the world by 2010." They've had mixed results. With the EU's recent expansion, its gross domestic product of 13.8 trillion dollars tops that of the U.S. (at 11.7 trillion). Yet some wealthy EU nations such as Germany and the Netherlands struggle with high unemployment and slow growth, due in part to welfare-state economics. To remain competitive, the EU hopes to increase investment in new technologies.



KEEPING FAITH

While secularism is on the rise and church attendance is sliding in parts of Europe, new mosques are transforming its skylines. Britain now has about a thousand mosques, up from 613 in 1996. In several countries violence has erupted between a swelling Muslim minority and majority populations following terrorist attacks by Islamist extremists. Mosques and Muslim gravesites have been vandalized, and more Muslims are reporting incidents of discrimination.



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Contents

King Tut—2

KENNETH GARRETT, EGYPTIAN MUSEUM, CAIRO

FEATURES

DEPARTMENTS

THE COVER
Forensics puts a face on King Tut.
BY KENNETH GARRETT
ART BY ELISABETH DAYNÈS

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From the Editor

ART BY ELISABETH DAYNÈS; PHOTOGRAPHS BY KENNETH GARRETT AND MARK THIESSEN, NGS; DIGITAL COMPOSITE AND COLORATION BY NGM ART

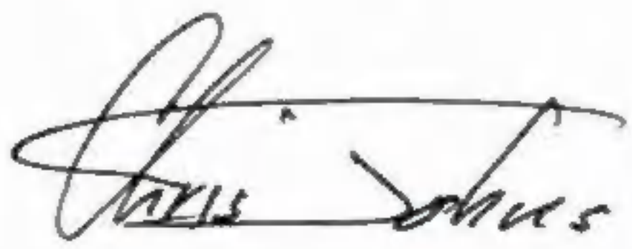
What happens when 21st-century technology—in this case a CT scanner—meets the 3,300-year-old mummy of an Egyptian pharaoh? A lot. First of all, there's this month's cover image, a visualization of the boy king Tutankhamun. Then there is discussion, debate, perhaps even controversy.

We turned the CT scan evidence over to forensic anthropologist Jean-Noël Vignal. Guided by Vignal, sculptor Elisabeth Daynès made the reconstruction on our cover. Tut's features turned out to be predominantly Caucasoid, colliding head-on with the opinion of some scholars that ancient Egyptians were black Africans.

We may never know the pharaoh's skin color. "Brown, black, or middle brown-black, it's only supposition," says Vignal. Our solution was to model the color on modern Egyptian skin tones, which vary across a wide spectrum. No doubt reader reaction will follow a spectrum equally as wide.

Our cover image is a wonderful example of the power of science—and its limitations. Even the most stringent inquiry rubs up against cultural expectations, not to mention Hollywood's spin machine. For many people, Ramses II will always look like Yul Brynner, who played the pharaoh in *The Ten Commandments.*

"A scientific man ought to have no wishes, no affections—a mere heart of stone," Charles Darwin once wrote. Most of us aren't quite so rigorous. We harbor wishes and affections of our own.



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JUNE 13 & 14, 9 P.M. ET/PT

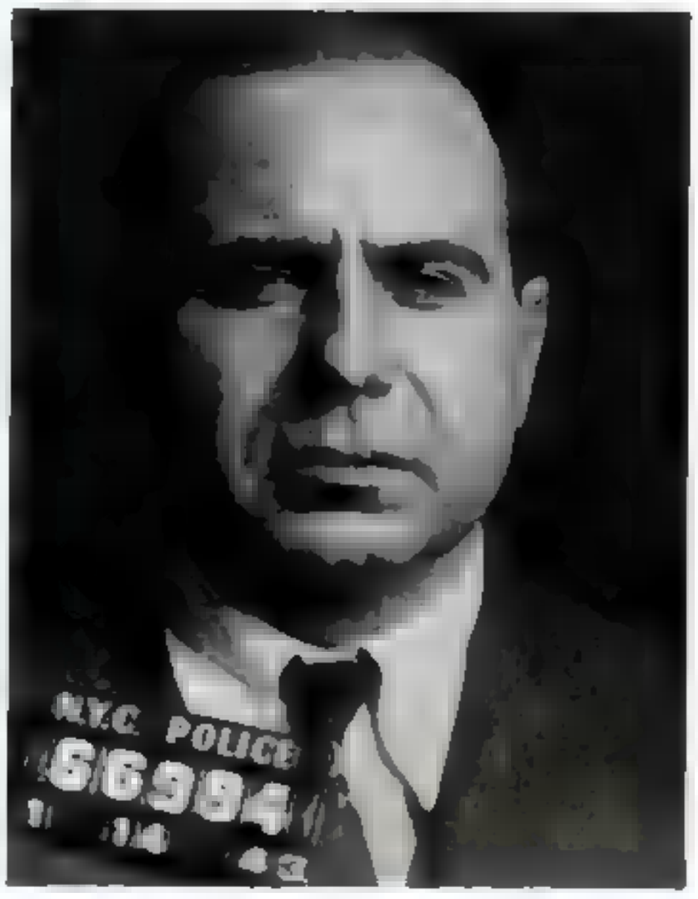
Inside the Mafia

It's a tale soaked in blood and betrayal, vengeance and greed. *Inside the Mafia* goes beyond the romanticized versions of gangsters portrayed in *The Godfather* and *The Sopranos* and presents the harrowing reality of a global crime industry guided by the motto, "It's not personal, it's business."

The show traces the mob's beginnings from clan-based gangs in Sicily that expanded and evolved in America during the immigration wave of the early 20th century. Among those who moved to New York were the families of Joe Bonanno (top), known as Joe "Bananas," and Carmine "Lilo" Galante (bottom). These two men helped transform the American mob from an assortment of competing fiefdoms into a political and economic empire.

The story moves from the back alleys of New York and Chicago to Las Vegas, where the mob dominated the gambling scene. You'll relive the fateful days in the late 1950s when the American and Sicilian Mafias joined forces to control the drug trade, a move that brought in billions of dollars but energized a government crackdown.

Along the way, you'll go behind the scenes with Bill Bonanno, Joe's son, who reveals the initiation rite mobsters went through to join "the family." And you'll meet undercover FBI agent Joe Pistone, aka Donnie Brasco, who lived inside the mob for six years. Experience their tales of life and death *Inside the Mafia.*



SUNDAYS, 8 P.M. ET/PT

EXPLORER

Tune in to National Geographic Channel's award-winning documentary series *Explorer* and experience unforgettable stories. Host Lisa Ling takes you behind the headlines to examine the people, creatures, forces, and events that shape our world. Track the 2003 U.S. air attack on Baghdad and glimpse new, high-tech combat tools as *Explorer* investigates the use of precision-guided weapons. And witness the different ways people caught in the paths of monster hurricanes in Florida survive—and study—the deadly winds. Every week *Explorer* takes you deep into the story for unparalleled insight and access—and a good dose of adventure.

Find out what's on and how to get the Channel in your area at *nationalgeographic.com/channel.* Programming information is accurate at press time. Consult local listings.

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KING TUT **See details from King Tutankhamun's CT scan** and watch as a 3-D re-creation of Tut's face morphs into life. ■ **INTERACTIVE ANIMATION** Fly over Egypt's Valley of the Kings and enter Tut's tomb. Zoom in to see close-ups of his burial chamber and manipulate images of the golden shrines and coffins. ***nationalgeographic.com/magazine/0506***

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Behind the Scenes

INTERNATIONAL EDITIONS

Tsunami Hits Home

As a journalist, Tantyo Bangun knew he must go. Days after December's tsunami, though safe in the Jakarta offices of National Geographic Indonesia, the editor in chief of the GEOGRAPHIC's newest local-language edition left his debut issue's deadlines to travel to the Aceh region, where more than 100,000 were feared dead. Killer waves had devastated the community of Suwak Indrapuri there; soon Bangun found himself working on tsunami relief and a story too. "I helped drive a truck collecting bodies," he says. The article he wrote and photographed (above) appeared in the Indonesian GEOGRAPHIC as a local ZipUSA-style story. Now that its few survivors are leaving, he explains, the area "is a vanished zip code."

ADOPTIONS

Lost Girls Found

In the year since *China's Lost Girls* first aired, the *Explorer* show—highlighting the effects of China's one-child policy on the country's girls—has had a surprising response. "Many people contacted our agency to learn more about Chinese adoption," says Lindsay Yeakley of the Great Wall adoption agency, "and many started the process." Some parents are sharing the episode, made available on DVD by popular demand, with their Chinese-born daughters. Others see it as a kind of home movie. "For everyone who has adopted," says Richard Fulton, a father featured in the film, "it's a personal story."

INSIDE TORNADOES (PAGE 110)

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To learn more about ■ subject covered in this issue, try these National Geographic Society products and services. Call 1-888-225-5647 or log on to nationalgeographic.com *for more information.* ■ ***The Tornado Hunters*** airs on the National Geographic Channel, June 26, 9 p.m. ET/PT. Tornado Alley residents capture advancing twisters on camera. ■ ***Forces of Nature*** film. Watch weather at its worst on video ($19.95) or DVD ($24.95).

Calendar

MAY

"Tutankhamun and the Golden Age of the Pharaohs" exhibit. Ticket sales continue for the June 16 opening at the Los Angeles County Museum of Art. Call 1-877-TUT-TKTS or go to *kingtut.org*.

"Survey 2005: In Your Face" online feature. Participate in a groundbreaking global survey that will help scientists understand how we identify human facial expressions. Go to *ngm.com/Survey2005*.

JUNE

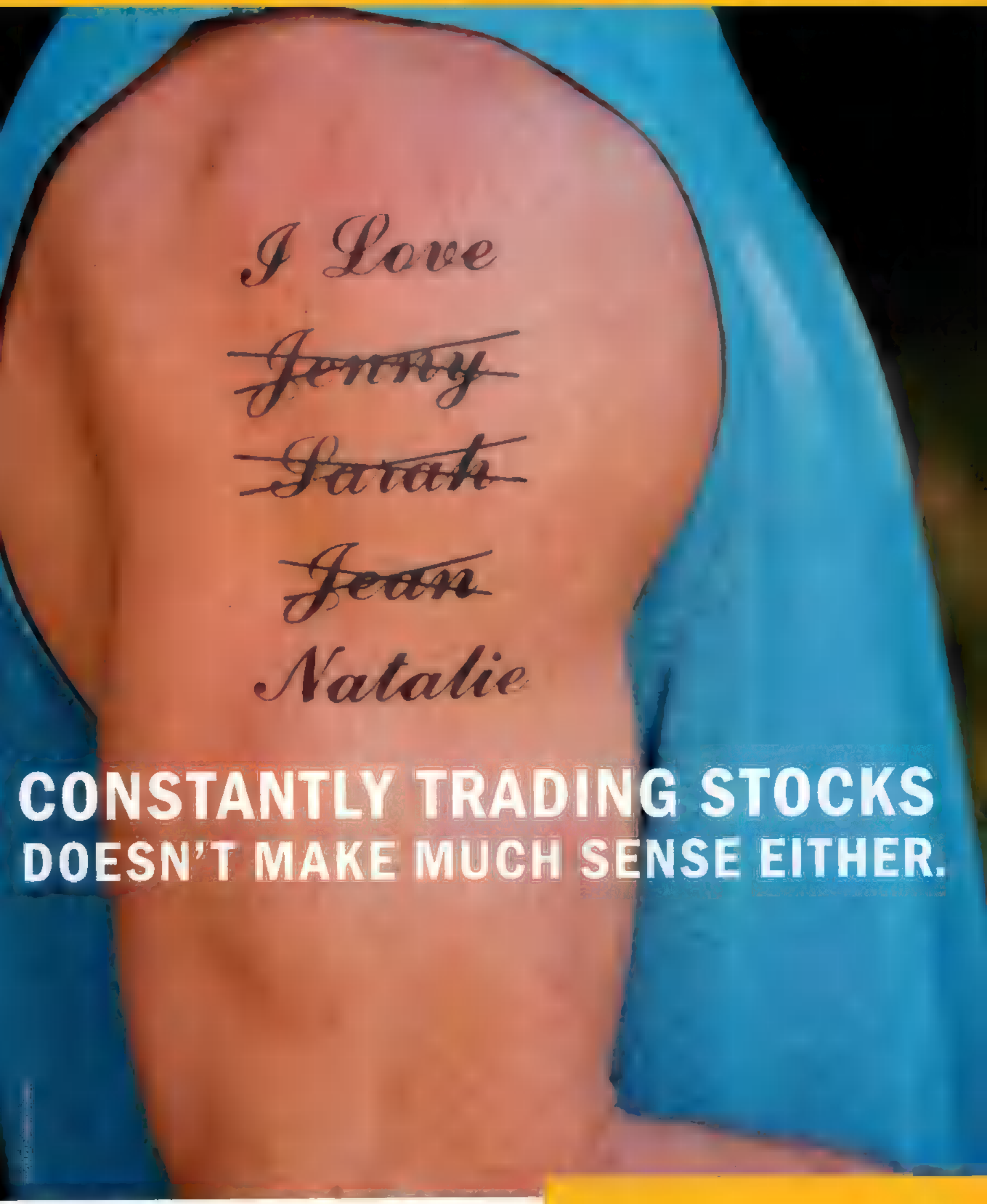
2 All Roads Film Project National Geographic brings indigenous filmmakers and their films to the Wairoa Maori Film Festival, June 2-6, in Wairoa, New Zealand.

9 Basya Schecter concert. Enjoy Jewish music of the Middle East. Pre-concert lecture at 7 p.m. Performance at 7:30 p.m. National Geographic Society, Washington, D.C.

13 *Inside the Mafia* This National Geographic Channel two-part special takes a historical look at the rise of organized crime. Airs June 13 and 14 at 9 p.m. ET/PT.

15 World Refugee Awareness UN High Commissioner for Refugees event includes panel discussions and exhibits, June 15. World Refugee Cultural Festival is June 18. National Geographic Society, Washington, D.C.

Calendar dates are accurate at press time; please go to *nationalgeographic.com* or call 1-800-*NGS-LINE (647-5463)* for more information.



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THROUGH A PHOTOGRAPHER'S EYE

Visions of Earth

As the early morning sun illuminated these scarlet ibises, the light through their feathers lent them a beautiful translucency against the black mudflats of Venezuela's Amacuro Delta. I had been following the Orinoco River in a helicopter when I saw the birds. I flew along with them for 20 minutes, shooting with a telephoto lens from far above. I wouldn't have wanted to disturb their journey.

—Yann Arthus-Bertrand

Decorate your desktop with these ibises in flight, in Fun Stuff at **nationalgeographic.com/magazine/0506**.

Forum

February 2005

In response to "A Wreck Revealed," the story of the discovery of the German ship Steuben, *readers expressed passionate opinions and offered vivid personal stories of World War II. One shared an experience similar to that of photographer Christoph Gerigk. She and her family also nearly boarded the* Wilhelm Gustloff, *which was sunk by the same Soviet submarine that torpedoed the* Steuben. *Read below about what saved her family.*

A Wreck Revealed

My heart almost stopped when I saw the photo of the mother and child boarding the *Steuben*. It could have been my mother holding me by the hand. I was born in Königsberg, East Prussia. In January 1945 my mother decided to leave our home since the advancing Russians were close to the city. Together with my older brother and sister we made our way to Gotenhafen to board the *Wilhelm Gustloff*. My mother told me later that I cried hysterically, and she was unable to calm me down. Something made her listen to her five-year-old daughter, and she decided not to board the ship.

ELKE DUFFY
Volcano, California

As you clearly pointed out, the passengers on the *Steuben* were refugees, among them many women, children, and wounded soldiers. No military or other threat came from the *Steuben*, or from the *Wilhelm Gustloff*, or the *Goya*. Therefore, in my opinion, the attacks were war crimes.

HEINRICH GASTEIGER
Munich, Germany

You offer a heartrending account of the "unspeakable panic" on board the *Steuben* as its passengers, 80 percent of whom were German soldiers, "were jumping into the frigid water." However, as I read of their suffering, I could not help but wonder whether any of the *Steuben*'s passengers participated, or chose to look the other way, as Germany's *Einsatzgruppen*, the mobile killing units, prowled through eastern European cities. The passengers on board the *Steuben* had some chance of survival, small though it may have been. I cannot say the same for my Hungarian relatives whom the Nazis sent to the gas chambers.

JIM GROSSFELD
Bethesda, Maryland

While it is commendable to point to the suffering of the population during World War II and its aftermath, you didn't mention

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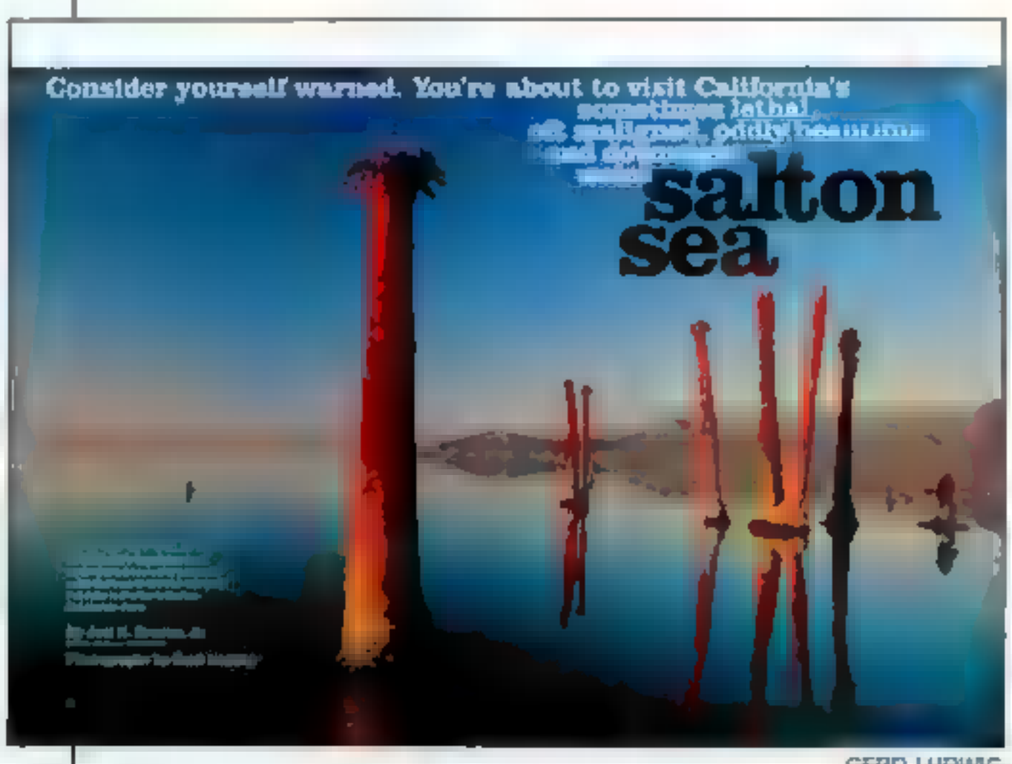

GERD LUDWIG

Eccentric Salton Sea

Your article on the Salton Sea was very valuable for those of us involved in the restoration process. The most difficult part has been finding an acceptable—and affordable—plan on which all interested stakeholders can agree. Since the sea is far from a major urban center, many outside the local area are unaware of the potentially disastrous environmental repercussions of a dead Salton Sea. For example, what would happen to the more than 400 species of birds—including the endangered brown pelican and the Yuma clapper rail—that call the sea home? What happens to an already dust-laden environment when more of the shore is exposed? I thank you for profiling the sea and bringing greater awareness to the environmental issues that it faces. I will continue to do the same.

REPRESENTATIVE BOB FILNER
U.S. Congress
Washington, D.C.

Local interests have turned the Salton Sea into a witches' brew of chemical runoff and invasive species. I say let it bake dry in the sun. If those same local interests of agribusiness and real estate developers find themselves inconvenienced by the return of the Salton Sink, I shall be utterly without sympathy.

WILLIAM GLUSMAN
Wheaton, Illinois

Has anyone suggested that water could be siphoned over the mountains and down to the Salton Sea from the coast? The drop in altitude could provide sufficient power to run the water through a desalination plant, eventually enabling the salinity of the sea to be controlled. It could also supply fresh water for agricultural and domestic use.

DOUGLAS MAYNARD
Blackboys, East Sussex

that the ship was named after the Prussian-American hero Friedrich Wilhelm von Steuben, who trained the American military during the American Revolution and was instrumental in defeating the English soldiers.

JULIUS A. LOISCH
Kokomo, Indiana

The Empty Quarter

How refreshing it is to read about the Empty Quarter and its people—real, interesting, hospitable—real Arabs. It was nice to sense the admiration your author has for them and his respect for their way of life. It is in contrast to the often biased attitudes of much of the Western media. Your magazine celebrates the diversity of humankind and thereby makes the world a better place. I thank you.

PAUL FEWEL
Boulder Creek, California

The camels silhouetted by late-day sun cast shadows worthy of Giacometti's spindly figures. These shadows, not the "ships of the desert" themselves, attract, hold, and mesmerize the eye. Their impenetrable blackness is riveting, and their sharply outlined shapes, altered by the magic of light, stand out like some otherworldly petroglyphs. It is a magnificent optical illusion.

VYTAUTAS MATULIONIS
Cleveland Heights, Ohio

Great Gray Owls

Being bird enthusiasts, we were delighted to see not only the great gray owls feature but also the owl on the cover. The day after the magazine arrived, my wife called me to the kitchen window, from which we watched a large gray owl as it stood in our backyard. Could this have been a coincidence?

ARTHUR FRANK JOHNSON
Spotswood, New Jersey

Lights, Camera, India

I enjoyed reading your article and its focus on *Veer-Zaara*. Years of partition, misunderstanding, suspicion, and war have been painful for the Indian subcontinent. While much later than many would have liked, the process of rapprochement between Pakistan and India has now begun. Films like *Veer-Zaara*—

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which highlight positive characters from both countries—can play an effective role in increasing the understanding and empathy between the two nations. Despite being apart for more than 50 years, the people of Pakistan and India share much in common.

SHADMAN RIAZ
Boston, Massachusetts

I love Bollywood movies both for the mesmerizing song-and-dance numbers and for the chance to see a bit of popular culture from another part of the world. The fact that the plots verge on fantasy is part of the fun. I tend to doubt that *Veer-Zaara*, which I saw last year, will help heal Indo-Pakistani relations. A large part of its appeal, after all, lies in a distinguishing characteristic of Bollywood films: characters too good to be true.

DIANA CHAPMAN
Fort Lee, New Jersey

I tend to doubt that [the film] *Veer-Zaara* will help heal Indo-Pakistani relations. A large part of its appeal, after all, lies in a distinguishing characteristic of Bollywood films: characters too good to be true.

The image in the story is the correct orientation. The image in On Assignment was unintentionally reversed in production.

ZipUSA: Wilmington, Delaware

Excessive consumer spending is justly emphasized as a cause of credit card debt and bankruptcy. However, I saw little comment regarding medical bills contributing to American debt. The journal *Health Affairs* has just released a study stating that half of all personal bankruptcies in the U.S. are now caused by medical costs.

AARON CHUBB
Lethbridge, Alberta

On Assignment

One of photographer George Steinmetz's images of Shibam, Yemen, is printed in reverse. The image in On Assignment shows the mosque in one orientation, and the image on pages 6-7 in the "Empty Quarter" story in another. Which one is correct?

FRANCIS SCHAFER
Seattle, Washington

Geographica: Muslims in America

I noticed the photograph of Dar al Islam in New Mexico. I have visited this mosque many times because of its immense size and serene beauty sitting on a mesa overlooking the village of Abiquiu and the Rio Chama Valley. As a Catholic, I never completely understood the true meaning or significance of the mosque until I was enlightened by a 16-year-old Muslim. Dar al Islam is an organization supporting communication and understanding between Islam and other religions. I am grateful to walk into this mosque and know it is a special, sacred place filled with acceptance. I would suggest other Christians visit the many mosques in America, but take along a Muslim. We all share the same God. We just need the translation.

JOHN ATLEE
Albuquerque, New Mexico

Flashback

My father, Roy H. Hattrup, designed and built the Hoot Hoot I Scream owl in 1927 on Valley Boulevard in Rosemead, California. The head did rotate back and forth, and the eyes would blink. They were made from headlights taken from an old Buick. The owl was moved to South Gate, California, in 1928 as there was no business in its original location. The Firestone Tire and Rubber Company was opening there that year, and it was hoped there would be more customers. My family turned the owl into a café in 1930. My mother, Tillie Hattrup, sold plate dinners during WWII for 25 cents because of price control. It was a great surprise to see this picture in NATIONAL GEOGRAPHIC.

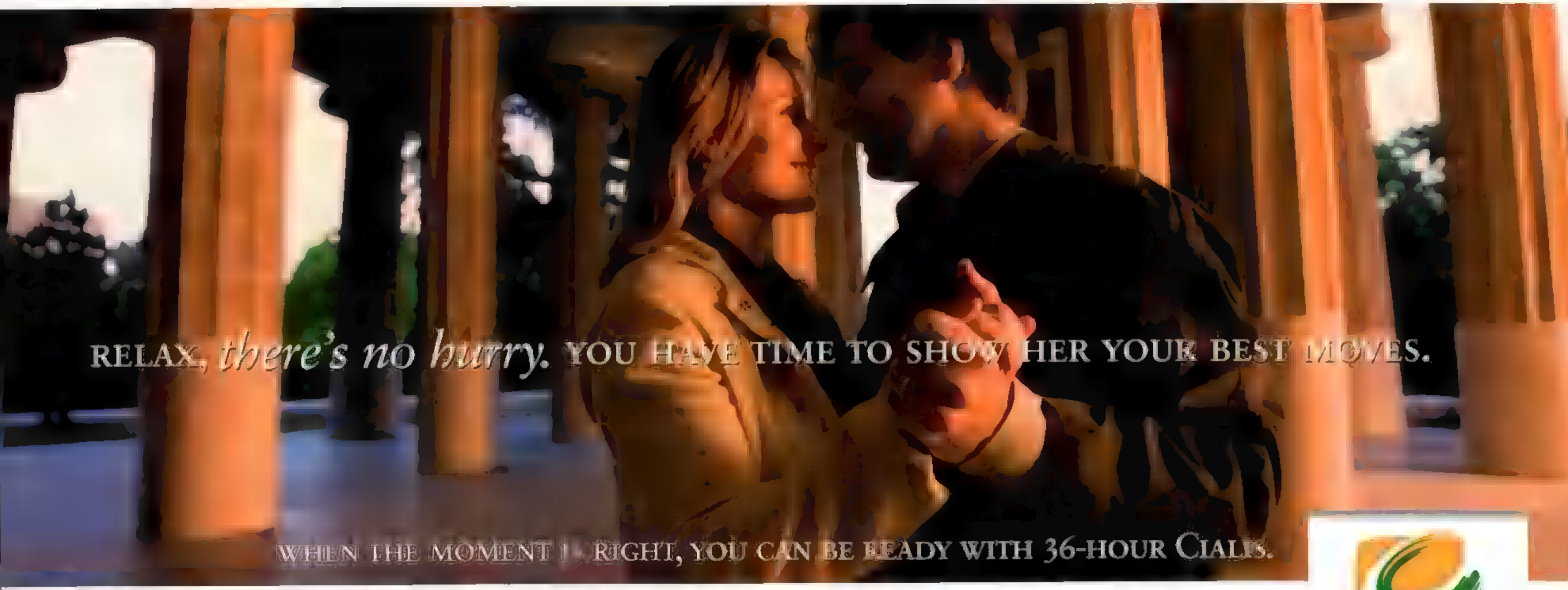
EDWARD F. HATTRUP
Ramona, California

You say, "Exactly why the Hoot Hoot's owner used a giant bird to help sell ice cream has been lost to history." The reason for the symbolism of the owl has not been lost to many of us. I am 61 years old, but I still remember the old verse: "I scream. You scream. We all scream for ice cream." Since owls are known for screaming (or screeching), it is easy for anyone familiar with the verse to understand the iconography of the owl as an ice-cream stand, especially one that proclaims, above its entry, Hoot Hoot I Scream!

HELEN O. VON SALZEN
Fort Lauderdale, Florida

Cialis is not for everyone. If you take nitrates, often used for chest pain (also known as angina), or alpha-blockers (other than Flomax 0.4 mg once daily), prescribed for prostate problems or high blood pressure, do not take Cialis. Such combinations could cause a sudden, unsafe drop in blood pressure. Don't drink alcohol in excess (to ■ level of intoxication) with Cialis. This combination may increase your chances of getting dizzy or lowering your blood pressure. Cialis does not protect a man or his partner from sexually transmitted diseases, including HIV.

The most common side effects with Cialis were headache and upset stomach. Backache and muscle ache were also reported, sometimes with delayed onset. Most men weren't bothered by the side effects enough to stop taking Cialis. Although a rare occurrence, men who experience an erection for more than 4 hours (priapism) should seek immediate medical attention. Discuss your medical conditions and medications with your doctor to ensure Cialis is right for you and that you are healthy enough for sexual activity.



Cialis (see-AL-iss) ■ the only erectile dysfunction (ED) tablet clinically proven to both work fast and work for up to 36 hours.* Having up to 36 hours lets you respond to your partner when the moment is right. Men with ED and their partners agree, Cialis improves erectile function for a satisfying experience.

Ask your doctor if prescription Cialis is right for you. See important safety information above and Patient Information on following page.

**Individual results may vary. Not studied for multiple attempts per dose. In clinical trials, Cialis was shown to improve, up to 36 hours after dosing, the ability of men with ED to have a single successful intercourse attempt.*

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Patient Information
CIALIS® (See-AL-Iss)
(tadalafil) tablets

Read the Patient Information about CIALIS before you start taking it and again each time you get a refill. There may be new information. You may also find it helpful to share this information with your partner. This leaflet does not take the place of talking with your doctor. You and your doctor should talk about CIALIS when you start taking it and at regular checkups. If you do not understand the information, or have questions, talk with your doctor or pharmacist.

What important information should you know about CIALIS?

CIALIS can cause your blood pressure to drop suddenly to an unsafe level if it is taken with certain other medicines. You could get dizzy, faint, or have a heart attack or stroke.

Do not take CIALIS if you:

- **take any medicines called "nitrates."**
- **use recreational drugs called "poppers" like amyl nitrate and butyl nitrate.**
- **take medicines called alpha blockers, other than Flomax® (tamsulosin HCl) 0.4 mg daily.**

(See "Who should not take CIALIS?")

Tell all your healthcare providers that you take CIALIS. If you need emergency medical care for a heart problem, it will be important for your healthcare provider to know when you last took CIALIS.

After taking a single tablet, some of the active ingredient of CIALIS remains in your body for more than 2 days. The active ingredient can remain longer if you have problems with your kidneys or liver, or you are taking certain other medications (see "Can other medications affect CIALIS?").

What is CIALIS?

CIALIS is a prescription medicine taken by mouth for the treatment of erectile dysfunction (ED) in men.

ED is a condition where the penis does not harden and expand when a man is sexually excited, or when he cannot keep an erection. A man who has trouble getting or keeping an erection should see his doctor for help if the condition bothers him. CIALIS may help a man with ED get and keep an erection when he is sexually excited.

CIALIS does not:

- cure ED
- increase a man's sexual desire
- protect a man or his partner from sexually transmitted diseases, including HIV. Speak to your doctor about ways to guard against sexually transmitted diseases.
- serve as a male form of birth control

CIALIS is only for men with ED. CIALIS is not for women or children. CIALIS must be used only under a doctor's care.

How does CIALIS work?

When a man is sexually stimulated, his body's normal physical response is to increase blood flow to his penis. This results in an erection. CIALIS helps increase blood flow to the penis and may help men with ED get and keep an erection satisfactory for sexual activity. Once a man has completed sexual activity, blood flow to his penis decreases, and his erection goes away.

Who can take CIALIS?

Talk to your doctor to decide if CIALIS is right for you.

CIALIS has been shown to be effective in men over the age of 18 years who have erectile dysfunction, including men with diabetes or who have undergone prostatectomy.

Who should not take CIALIS?

Do **not** take CIALIS if you:

- **take any medicines called "nitrates"** (See "What important information should you know about CIALIS?"). Nitrates are commonly used to treat angina. Angina is a symptom of heart disease and can cause pain in your chest, jaw, or down your arm.

  Medicines called nitrates include nitroglycerin that is found in tablets, sprays, ointments, pastes, or patches. Nitrates can also be found in other medicines such as isosorbide dinitrate or isosorbide mononitrate. Some recreational drugs called "poppers" also contain nitrates, such as amyl nitrate and butyl nitrate. Do not use CIALIS if you are using these drugs. Ask your doctor or pharmacist if you are not sure if any of your medicines are nitrates.
- **take medicines called "alpha blockers", other than Flomax® 0.4 mg daily.** Alpha blockers are sometimes prescribed for prostate problems or high blood pressure. If CIALIS is taken with alpha blockers other than Flomax® 0.4 mg daily, your blood pressure could suddenly drop to an unsafe level. You could get dizzy and faint.
- **you have been told by your healthcare provider to not have sexual activity because of health problems.** Sexual activity can put extra strain on your heart, especially if your heart is already weak from a heart attack or heart disease.
- **are allergic to CIALIS or any of its ingredients.** The active ingredient in CIALIS is called tadalafil. See the end of this leaflet for a complete list of ingredients.

What should you discuss with your doctor before taking CIALIS?

Before taking CIALIS, tell your doctor about all your medical problems, including if you:

- **have heart problems** such as angina, heart failure, irregular heartbeats, or have had a heart attack. Ask your doctor if it is safe for you to have sexual activity.
- **have low blood pressure or** have high blood pressure that is not controlled
- **have had a stroke**
- **have liver problems**
- **have kidney problems or require dialysis**
- **have retinitis pigmentosa,** a rare genetic (runs in families) eye disease
- **have stomach ulcers**
- **have a bleeding problem**
- **have a deformed penis shape** or Peyronie's disease
- **have had an erection that lasted more than 4 hours**
- **have blood cell problems** such as sickle cell anemia, multiple myeloma, or leukemia

Can other medications affect CIALIS?

Tell your doctor about all the medicines you take including prescription and non-prescription medicines, vitamins, and herbal supplements. CIALIS and other medicines may affect each other. Always check with your doctor before starting or stopping any medicines. Especially tell your doctor if you take any of the following:

- medicines called nitrates (See "What important information should you know about CIALIS?")
- medicines called alpha blockers. These include Hytrin® (terazosin HCl), Flomax® (tamsulosin HCl), Cardura® (doxazosin mesylate), Minipress® (prazosin HCl) or Uroxatral® (alfuzosin HCl).
- ritonavir (Norvir®) or indinavir (Crixivan®)
- ketoconazole or itraconazole (such as Nizoral® or Sporanox®)
- erythromycin
- other medicines or treatments for ED

How should you take CIALIS?

Take CIALIS exactly as your doctor prescribes. CIALIS comes in different doses (5 mg, 10 mg, and 20 mg). For most men, the recommended starting dose is 10 mg. **CIALIS should be taken no more than once a day.** Some men can only take a low dose of CIALIS because of medical conditions or medicines they take. Your doctor will prescribe the dose that is right for you.

- If you have kidney problems, your doctor may start you on a lower dose of CIALIS.
- If you have kidney or liver problems or you are taking certain medications, your doctor may limit your highest dose of CIALIS to 10 mg and may also limit you to one tablet in 48 hours (2 days) or one tablet in 72 hours (3 days).

Take one CIALIS tablet before sexual activity. In some patients, the ability to have sexual activity was improved at 30 minutes after taking CIALIS when compared to a sugar pill. The ability to have sexual activity was improved up to 36 hours after taking CIALIS when compared to a sugar pill. You and your doctor should consider this in deciding when you should take CIALIS prior to sexual activity. Some form of sexual stimulation is needed for an erection to happen with CIALIS. CIALIS may be taken with or without meals.

Do not change your dose of CIALIS without talking to your doctor. Your doctor may lower your dose or raise your dose, depending on how your body reacts to CIALIS.

Do not drink alcohol to excess when taking CIALIS (for example, 5 glasses of wine or 5 shots of whiskey). When taken in excess, alcohol can increase your chances of getting a headache or getting dizzy, increasing your heart rate, or lowering your blood pressure.

If you take too much CIALIS, call your doctor or emergency room right away.

What are the possible side effects of CIALIS?

The most common side effects with CIALIS are headache, indigestion, back pain, muscle aches, flushing, and stuffy or runny nose. These side effects usually go away after a few hours. Patients who get back pain and muscle aches usually get it 12 to 24 hours after taking CIALIS. Back pain and muscle aches usually go away by themselves within 48 hours. Call your doctor if you get a side effect that bothers you or one that will not go away.

CIALIS may uncommonly cause:

- **an erection that won't go away (priapism).** If you get an erection that lasts more than 4 hours, get medical help right away. Priapism must be treated as soon as possible or lasting damage can happen to your penis including the inability to have erections.
- vision changes, such as seeing a blue tinge to objects or having difficulty telling the difference between the colors blue and green.

These are not all the side effects of CIALIS. For more information, ask your doctor or pharmacist.

How should CIALIS be stored?

- Store CIALIS at room temperature between 59° and 86°F (15° and 30°C).
- **Keep CIALIS and all medicines out of the reach of children.**

General information about CIALIS:

Medicines are sometimes prescribed for conditions other than those described in patient information leaflets. Do not use CIALIS for a condition for which it was not prescribed. Do not give CIALIS to other people, even if they have the same symptoms that you have. It may harm them.

This leaflet summarizes the most important information about CIALIS. If you would like more information, talk with your healthcare provider. You can ask your doctor or pharmacist for information about CIALIS that is written for health professionals.

For more information you can also visit www.cialis.com, or call 1-877-CIALIS1 (1-877-242-5471).

What are the ingredients of CIALIS?

Active Ingredient: tadalafil

Inactive Ingredients: croscarmellose sodium, hydroxypropyl cellulose, hypromellose, iron oxide, lactose monohydrate, magnesium stearate, microcrystalline cellulose, sodium lauryl sulfate, talc, titanium dioxide, and triacetin.

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These watches were among the most stylish of the roaring 20's. The Stauer watch design that you see here has the antique color, the vintage style and the innovative functions of the original that we have seen in a Swiss museum. Even the Breguet™ style hands are designed from the original. The owner of this legendary multi-functional watch is sure to look distinguished and set apart from the crowd. This Stauer watch is a limited edition, allowing you to wear a watch far more exclusive than many luxury watches.

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A P H I C A

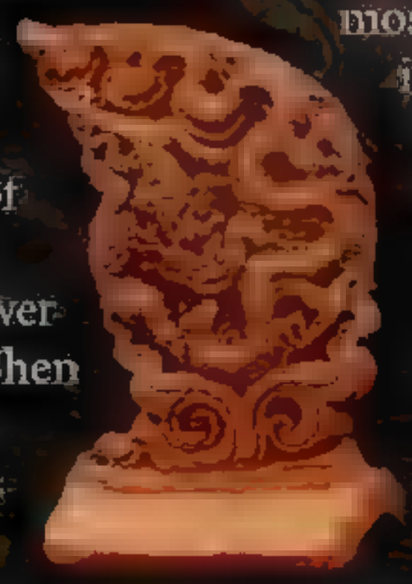
C R E A T O R S O F T H E U N I V E R S E

ARCHAEOLOGY

Vietnam Unearths Its Royal Past

Lost citadel found in Hanoi

A few years ago the Vietnamese government began planning a new national assembly house to be located in central Hanoi, an area of the city they knew had once been the seat of power for imperial Vietnam. When ground was broken, the builders of the country's future found artifacts spanning 1,300 years of its past. The Hanoi site has proved the most productive archaeological dig ever undertaken in the country. Among the millions of artifacts uncovered are many from the legendary Thang Long Citadel, an elaborate arrangement of palaces and meeting halls that for



BUDDHIST ROOF ORNAMENT (INSET ABOVE); ARTIST'S RENDERING OF ORNAMENT ON CITADEL ROOF; VIETNAM INSTITUTE OF HISTORICAL RESEARCH (ABOVE); NGUYEN HOAI THU (ALL)

centuries lay at the center of Vietnamese culture and society.

Unicorn heads of carved marble, celadon platters, roof ornaments, and ceramic tiles and bricks—even the bones of elephants, the workhorses of an earlier era—speak to the past glories of Vietnam. The excavation layers extend down 14 feet, and the oldest ruins discovered, those of brick-lined wells, date back to the seventh century A.D., when this Red River Delta region was under Chinese control. That control ended in the tenth century; in the eleventh construction of the Thang Long Citadel began.

"We've known from ancient texts that this part of the city was where the palaces and temples of the inner court were located," says Cornell University historian Keith Taylor, an expert on ancient Vietnam. The new findings, he says, "give concrete form to what had been simply imagination."

While only a fraction of the site has been excavated, preliminary reports are already shedding new light on the cultural and political past of Vietnam. Particularly important are the discoveries from the 11th through 15th centuries, when Vietnamese culture was at its peak under the Ly and Tran dynasties. Other artifacts speak to a long history of cultural exchange with the outside world. The most recent finds include 19th-century French wine bottles from the colonial period, which lasted until the mid-20th century.

To contemporary Vietnamese many of the citadel's artifacts must look familiar. A 15th-century pottery bowl bears a remarkable resemblance to bowls still produced in Bat Trang, a village on the outskirts of Hanoi that still ferries its ceramics (below) to markets along the Red River. The village has a 500-year history as a ceramic- and brick-making center, and Bat Trang bricks have been unearthed at the imperial citadel site.

"Bricks from the kilns of my family, the Tran family, are said to be the best in Bat Trang," says Tran Van Do, who operates a brick-and-ceramic factory (above) in the village. "Our bricks used to be the first choice of the royal citadel builders." He also sees a clear connection between the ceramics of earlier generations and those of his own generation, but he admits that "Our ceramics are not as soulful and emotional as those of our ancestors. We still have a lot to learn from them."

And Vietnam still has a lot to learn about its imperial past. Experts expect that the citadel excavations will continue for years. Who knows what could be unearthed in that time.

—Dana Sachs and Le Quang Vu

NGUYEN HOAI LINH (BOTH)

WEBSITE EXCLUSIVE Find links and resources selected by our Research Division, in Departments at **nationalgeographic.com/magazine/0506**.

The colonial me

was the hope of a new nation.

A cooper's apprentice one day,

a revolutionary the next.

Shoulder-to-shoulder he stood with his countrymen

against Cornwallis.

And in Yorktown, victory was theirs.

What trust bestowed upon a man of such tender age!

I mean,

I can't even get the stupid car keys.

Vacation packages, including the Colonial Escape package, are detailed in the new 2005 Colonial Williamsburg Vacation Planner and are featured on our website. To receive a copy of the planner, or to make reservations, visit ColonialWilliamsburg.com or call us at 1-800-HISTORY.

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WILLIAMSBURG, VIRGINIA

MAURICE ASCANI, SOS FAUNE DU NIGER

MEGAFLYOVER

Antelope on the Brink

Mike Fay's report from the field

We'd been flying for hours, deeper and deeper into the desert of southeastern Niger. The mission: to find what is probably the last wild population of the great Saharan antelope called the addax (above)—the most endangered animal of its size in Africa.

Pilot Peter Ragg flew our bright red Cessna low over two parallel dunes. The pale sand below us was dotted by the black tufts of *Centotheca* bushes, the semisucculent plants that are a favorite food of the addax. Then, almost as if the dune extruded them, two perfect addaxes materialized. Their long tails swung from side to side as they galloped—heads held high on massive necks, spiral horns reaching for the sky. We made a few turns in the plane, then let them be. In just a few seconds they were swallowed again by the Sahara. Soon they could just as easily disappear from the planet.

In September 2004 the government of Niger and a small NGO called SOS Faune du Niger surveyed this last known pocket of wild addaxes. They counted 128 individuals. Since then, the number has dropped as poachers have taken more for trophies or bush meat. How many addaxes remain in the Sahara is anybody's guess, but those that do survive could be considered the living dead: There may not be a viable population left to reproduce.

I'm now helping devise an emergency plan for the last wild addaxes. With a few hundred thousand dollars, some trucks, and a strong alliance with the local Toubou nomads, we may just be able to save these guys from extinction.—*J. Michael Fay*

MEGAFLYOVER UPDATE For dispatches, photographs, videos, and related educational activities from Mike's trip across Africa, go to **nationalgeographic.com/magazine/megaflyover.**

GEO NEWS

GEMOLOGY

■ **The 45.2-carat Hope Diamond—the world's largest blue diamond—was cut from an even bigger stone.** Recent studies support the assumption that the Hope was once part of a 69-carat jewel stolen during the French Revolution from King Louis XVI. He had the stone, originally from India, cut down from 115 carats.

CONSERVATION

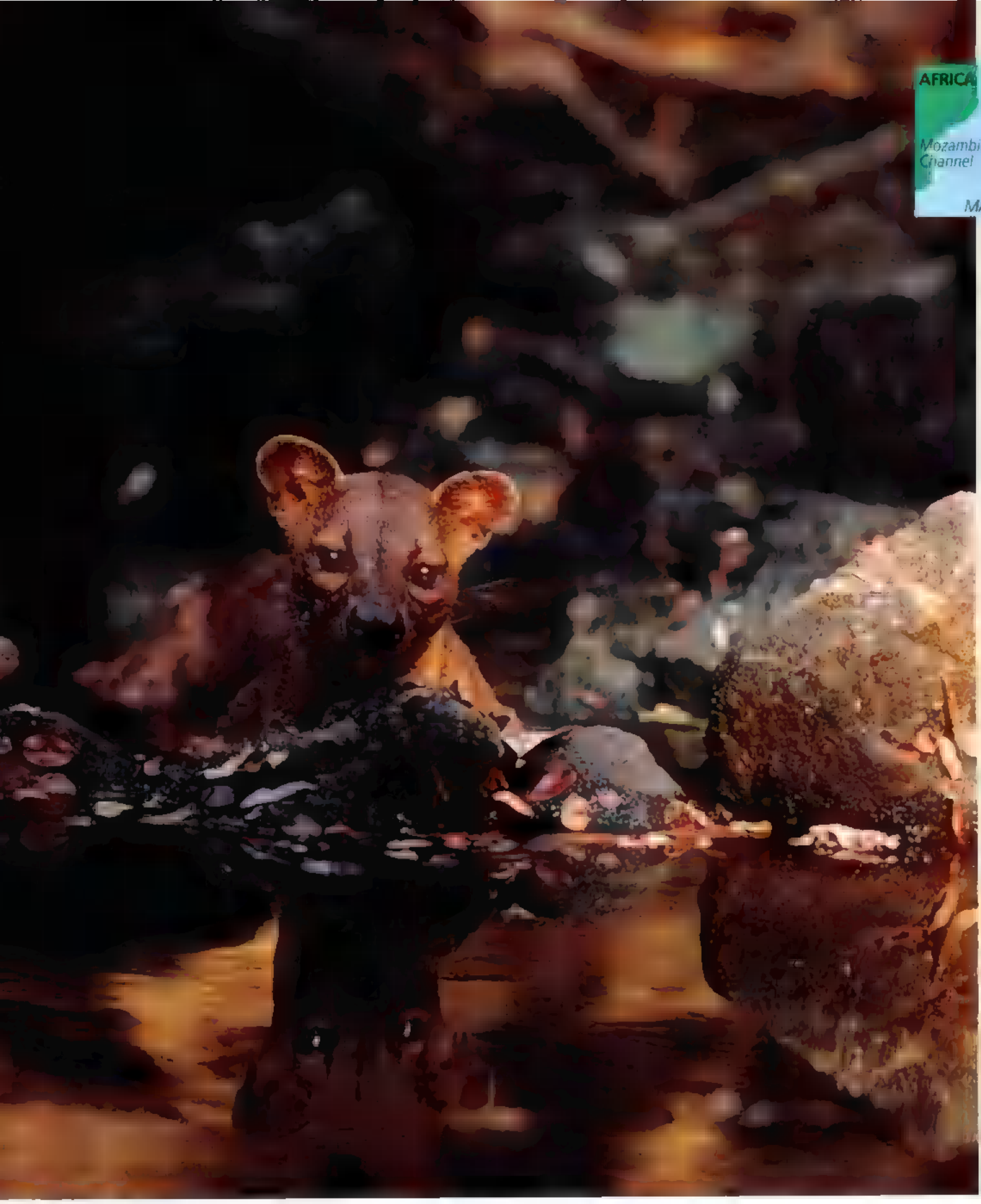
■ **White-tailed deer threaten survival of wild ginseng** and other rare forest flora in the Appalachian region of the U.S. If booming deer populations keep growing, experts say, the animals' browsing could cause plant extinctions within decades. A traditional Appalachian herb, local ginseng is in high demand from Asian buyers.

CLIMATE

■ **Global warming is almost at the tipping point,** according to a study by an international climate change task force. Unless industrialized nations immediately reduce carbon dioxide emissions and increase "green" technology, irreversible environmental harm—including large-scale polar ice melting and the shutdown of the Gulf Stream current—may follow.

ANIMAL KINGDOM

■ **Australian authorities held a contest with prizes for the most effective cane toad traps.** They encouraged the public to solve the problem of the toxic-skinned invasive species, which has proved resistant to other controls. The estimated cane toad population in Australia is 100 million.



Fossa
(Cryptoprocta ferox)

Size: Body length, 60-80 cm; tail, 60-80 cm

Weight: 7-12 kg

Habitat: Madagascar's forests and woodland savannahs, from sea level to elevations of 2,000 m

Surviving number: Estimated at fewer than 2,500

Photographed by Pete Oxford

WILDLIFE AS CANON SEES IT

What to make of the fossa? Coming from an ancient line of carnivore predating felines and canines, it has curved, retractable claws like a cat and a flat-footed walk like a bear. Other animals know enough to give it a wide berth, as Madagascar's largest native predator can kill virtually anything it encounters. Many humans, however, don't know it as well as they believe. Common opinion holds that the fossa is a savage, brazen killer. But it is actually shy and reclusive, going out of its way to avoid people. Built to pursue prey, the fossa now finds itself pursued—by human hunters and the ravages of wide-scale habitat destruction.

As an active, committed global corporation, we join worldwide efforts to promote awareness of endangered species. Just one way we are working to make the world a better place—today and tomorrow.

Canon has teamed up with the Yellowstone Park Foundation to help scientists protect Yellowstone's wildlife through advanced imaging technologies.

Canon

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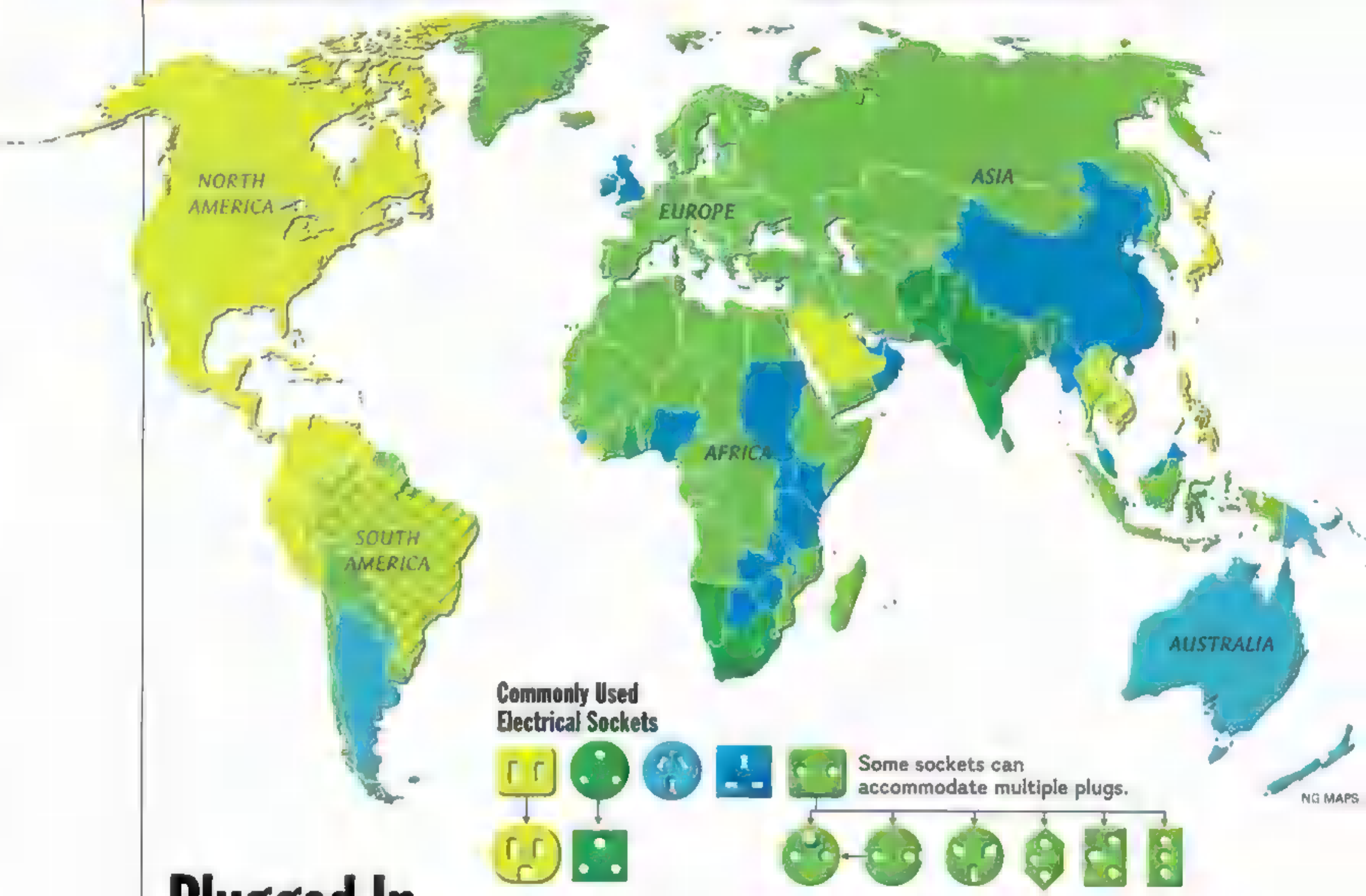
THE GEOGRAPHY OF EVERYDAY LIFE



Plugged In

Harvey Hubbell's "separable plug" garnered little public notice when the U.S. government awarded it a patent in November 1904. Thomas Edison's lightbulb had awed adoring crowds in 1879, but inventor Hubbell was more interested in practicality than fanfare. His plug and its companion socket eliminated the need to wire all appliances into a building's power supply—a potentially perilous task. The patent application declared that his new device would allow "persons having no electrical knowledge or skill" to connect the growing number of appliances requiring electric current.

But Hubbell's grand vision of an easy-to-plug-in world remains elusive—as any traveler who has attempted to pair a hair dryer from home with a foreign outlet can attest. In the early 1900s the U.S. developed unified standards for electrical plugs. Other nations adopted different plugs; some sanctioned more than one. Today 13 different plug-and-socket systems are in use around the world (map). The 25-nation European Union still can't agree on ■ plug. In 1996 Cenelec, the European body that sets electrical standards, abandoned its quest for ■ single "euro plug," but now most EU countries have adopted sockets that accept a variety of plugs.

Although power suppliers around the world have chosen alternating current (AC) over direct current (DC) as the most efficient way to deliver electricity to consumers, national standards for voltage and frequency vary—further contributing to globetrotters' hair dryer nightmares. Still, there's hope that the world will someday use ■ single plug. "I think it will happen," says Tom Conlin of Hubbell, Inc., the firm founded by the plug's inventor, "but probably not in our lifetime."

—*Peter Gwin*

ILLUSTRATION BY MATTHIAS KULKA, CORBIS

What tobacco issue is important to you?

The Serious Health Effects of Smoking

Youth Smoking Prevention

Quitting Smoking

Responsible Marketing

At philipmorrisusa.com you can find resources and information on many tobacco-related issues like these–including downloadable brochures with advice from experts on talking to kids about not smoking and tips on starting the conversation. You'll also find details on how we're partnering with retailers to **help** prevent kids from getting access to **cigarettes.** To find out more, visit us online **or call 1-877**-PMUSA-WEB.

philipmorrisusa.com

1-877-PMUSA-WEB

THIS GREAT PLACE

Beneath the Valley of the Kings

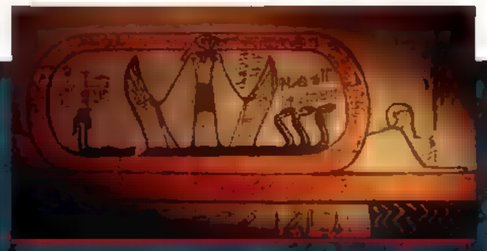
The sunbaked cliffs on the west bank of the Nile at Thebes were for centuries an exclusive Egyptian neighborhood—of the dead. The desert terrain cracks open into narrow valleys—including the Valley of the Queens and, the most important, the Valley of the Kings—named for those whose subterranean tombs honeycomb the area's steep limestone walls. For some 450 years during the New Kingdom (1539–1075 B.C.) this 50-acre valley was the pharaohs' necropolis. At least 30 rulers and their courtiers—many still unidentified—were buried in tombs filled with the riches they would need in the afterlife, but hidden from view to protect them from tomb robbers.

Tomb construction began soon after a pharaoh took the throne, and work might last for decades. Laborers used flint axes and bronze and copper chisels to carve long, inclined tunnels and rooms out of walls of solid rock. As tombs accumulated over the centuries, earlier royal burials were often forgotten. New tunneling sometimes ran head-on into older excavations. But this lack of a master plan did have its advantages—at least to history. It was debris from construction of another tomb and ancient workers' huts that obscured the entrance to Tutankhamun's tomb and helped protect its treasures for more than 3,000 years.

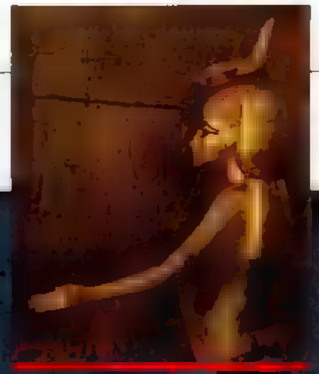
—Margaret G. Zackowitz and Zachary Petit

SOAR OVER THE VALLEY OF THE KINGS, then zero in on King Tut's tomb and meet the pharaoh face-to-face at **nationalgeographic.com/magazine/0506.**

Tawosret A queen in the Valley of the Kings, Tawosret was Seti II's widow and one the few female pharaohs. This bas-relief appears in her tomb, which was later appropriated by Sethnakhte.



Amenhotep II Art depicting the underworld journey of the dead adorns the tomb of Amenhotep II, whose mummy was discovered with more than a dozen others—probably placed here during a later dynasty's reorganization of the necropolis.



Tutankhamun Outstretched arms of a gilded goddess protect a canopic shrine containing Tut's internal organs, which were removed during mummification.

Ramses II Ramses the Great ruled for over 60 years and is said to have fathered some 100 children. His mummy is well traveled. Originally interred in its own tomb, it was later moved to Seti I's tomb, then hidden in an abandoned tomb shaft until discovered by robbers in the 1870s. Today the mummy lies in Cairo's Egyptian Museum.

Bay

Amenhotep II

Merneptah

Unknown

Maiherperi

Ramses V/VI

Unknown

Unknown

Unknown

Gold Tomb

Horemheb

Ramses II

Ramses III

Amenmesse

Tutankhamun
(See story on page)

Amarna cache

Ramses I

Ramses IX

Sons of Ramses II

Seti I

TOMB MODELS BY WALTON CHANTHEBAN MAPPING PROJECT, DAMNEH. PHOTOGRAPHS BY KENNETH GARRETT (TUT'S SHRINE AND RAMSES II PHOTOGRAPHED AT EGYPTIAN MUSEUM, CAIRO). NATIONAL GEOGRAPHIC MAPS


Ford

My Seven

Dipping Into the Gene Pool

Spencer Wells *Population geneticist, anthropologist*

Spencer Wells has collected DNA samples from people all over the world to trace the roots of human history. Now, as head of the new Genographic Project—a research partnership between the National Geographic Society and IBM—he's ready to collect yours (see *nationalgeographic.com/genographic*). Here are seven key paths he's followed along the genetic trail.

A NOMAD IN MONGOLIA MAY CARRY THE GENETIC LEGACY OF GENGHIS KHAN

MARK READ (TOP); OLIVIER RENCK, AURORA

1 Hadzabe This group of hunter-gatherers lives near Tanzania's Ngorongoro Crater and speaks a click-based language related to that of the San people of southern Africa. Genetic data indicate that the San and Hadzabe are among Earth's oldest intact populations, and that our species originated in Africa within the past 200,000 years.

2 Modern thinkers Climate change during the last ice age nearly wiped out our species; as few as 2,000 people were alive some 70,000 years ago. To survive, humans had to become smarter, developing behaviors including tool use to adapt to a range of climates.

3 Belukha It's the tallest peak in Siberia's Altai range. Local legends say that civilization will be reborn here after humanity destroys itself. Maybe those myths aren't so far-fetched after all: The Altai region was the source of population expansions starting some 35,000 years ago, including ones leading to the settlement of much of Eurasia and the Americas.

4 Yagnob Once the lingua franca of trade along the Silk Road, it's now spoken only by a small group in Central Asia and is disappearing fast. More than half the world's 6,000 languages will vanish by the end of the century.

5 Genghis Khan About 8 percent of men in Central and East Asia are descended from this 12th-century Mongol leader, according to DNA tests.

6 Jericho This Jordan Valley site offers a glimpse into Neolithic life ten thousand years ago, when humans began settling to farm. Many patterns of genetic variation come from the population expansions spurred by the development of agriculture.

7 Phoenicians DNA testing in Lebanon reveals that both Muslims and Christians there today share common Phoenician ancestors going back more than 5,000 years.

WHO WERE THE PHOENICIANS? Find out by watching an interview with newest Explorer-in-Residence Spencer Wells. You can also view a picture gallery and join our forum on DNA testing at **nationalgeographic.com/magazine/0410/feature2**.

VYTORIN treats the 2 sources of cholesterol.

FOOD

FAMILY

You probably know that cholesterol comes from food. But what you might not know is that your cholesterol has a lot to do with your family history. VYTORIN treats both sources of cholesterol.

A healthy diet is important, but when it's not enough, adding VYTORIN can help. VYTORIN helps block the absorption of cholesterol that comes from food and reduces the cholesterol that your body makes naturally.

In clinical trials, VYTORIN lowered bad cholesterol more than Lipitor alone. VYTORIN is a tablet containing two medicines: Zetia® (ezetimibe) and Zocor (simvastatin).

Important information: VYTORIN is a prescription tablet and isn't right for everyone, including women who are nursing or pregnant or who may become pregnant, and anyone with liver problems. Unexplained muscle pain or weakness could be a sign of a rare but serious side effect and should be reported to your doctor right away. VYTORIN may interact with other medicines or certain foods, increasing your risk of getting this serious side effect. So, tell your doctor about any other medications you are taking.

To learn more, call 1-877-VYTORIN or visit vytorin.com Please read the Patient Product Information on the adjacent page.

Continue to follow a healthy diet, and ask your doctor about adding VYTORIN.

Merck/Schering-Plough Patient Assistance Program

MERCK / Schering-Plough Pharmaceuticals

To find out if you qualify, call 1-800-347-7503.

VYTORIN™
(ezetimibe/simvastatin)

Treat the 2 sources of cholesterol.

VYTORIN™ (ezetimibe/simvastatin) Tablets

Patient Information about VYTORIN (VI-tor-in)
Generic name: ezetimibe/simvastatin tablets

Read this information carefully before you start taking VYTORIN. Review this information each time you refill your prescription for VYTORIN as there may be new information. This information does not take the place of talking with your doctor about your medical condition or your treatment. If you have any questions about VYTORIN, ask your doctor. Only your doctor can determine if VYTORIN is right for you.

What is VYTORIN?

VYTORIN is a medicine used to lower levels of total cholesterol, LDL (bad) cholesterol, and fatty substances called triglycerides in the blood. In addition, VYTORIN raises levels of HDL (good) cholesterol. It is used for patients who cannot control their cholesterol levels by diet alone. You should stay on a cholesterol-lowering diet while taking this medicine.

VYTORIN works to reduce your cholesterol in two ways. It reduces the cholesterol absorbed in your digestive tract, as well as the cholesterol your body makes by itself. VYTORIN does not help you lose weight.

Who should not take VYTORIN?

Do not take VYTORIN:

- If you are allergic to ezetimibe or simvastatin, the active ingredients in VYTORIN, or to the inactive ingredients. For ■ list of inactive ingredients, see the "Inactive ingredients" section at the end of this information sheet.
- If you have active liver disease or repeated blood tests indicating possible liver problems.
- If you are pregnant, or think you may be pregnant, or planning to become pregnant or breast-feeding.

VYTORIN is not recommended for use in children under 10 years of age.

What should I tell my doctor before and while taking VYTORIN?

Tell your doctor right away if you experience unexplained muscle pain, tenderness, or weakness. This is because on rare occasions, muscle problems can be serious, including muscle breakdown resulting in kidney damage.

The risk of muscle breakdown is greater at higher doses of VYTORIN.

The risk of muscle breakdown is greater in patients with kidney problems.

Taking VYTORIN with certain substances can increase the risk of muscle problems. It is particularly important to tell your doctor if you are taking any of the following:

- cyclosporine
- danazol
- antifungal agents (such as itraconazole or ketoconazole)
- fibric acid derivatives (such as gemfibrozil, bezafibrate, or fenofibrate)
- the antibiotics erythromycin, clarithromycin, and telithromycin
- HIV protease inhibitors (such as indinavir, nelfinavir, ritonavir, and saquinavir)
- the antidepressant nefazodone
- amiodarone (a drug used to treat an irregular heartbeat)
- verapamil (a drug used to treat high blood pressure, chest pain associated with heart disease, or other heart conditions)
- large doses (≥1 g/day) of niacin or nicotinic acid
- large quantities of grapefruit juice (>1 quart daily)

It is also important to tell your doctor if you are taking coumarin anticoagulants (drugs that prevent blood clots, such as warfarin).

Tell your doctor about any prescription and nonprescription medicines you are taking or plan to take, including natural or herbal remedies.

Tell your doctor about all your medical conditions including allergies.

Tell your doctor if you:

- drink substantial quantities of alcohol or ever had liver problems. VYTORIN may not be right for you.
- are pregnant or plan to become pregnant. Do not use VYTORIN if you are pregnant, trying to become pregnant or suspect that you are pregnant. If you become pregnant while taking VYTORIN, stop taking it and contact your doctor immediately.
- are breast-feeding. Do not use VYTORIN if you are breast-feeding.

Tell other doctors prescribing a new medication that you are taking VYTORIN.

How should I take VYTORIN?

- Take VYTORIN once a day, in the evening, with or without food.
- Try to take VYTORIN as prescribed. If you miss a dose, do not take an extra dose. Just resume your usual schedule.
- Continue to follow a cholesterol-lowering diet while taking VYTORIN. Ask your doctor if you need diet information.
- Keep taking VYTORIN unless your doctor tells you to stop. If you stop taking VYTORIN, your cholesterol may rise again.

What should I do in case of an overdose?

Contact your doctor immediately.

What are the possible side effects of VYTORIN?

See your doctor regularly to check your cholesterol level and to check for side effects. Your doctor may do blood tests to check your liver before you start taking VYTORIN and during treatment.

In clinical studies patients reported the following common side effects while taking VYTORIN: headache and muscle pain (see What should I tell my doctor before and while taking VYTORIN?).

The following side effects have been reported in general use with either ezetimibe or simvastatin tablets (tablets that contain the active ingredients of VYTORIN):

- allergic reactions including swelling of the face, lips, tongue, and/or throat that may cause difficulty in breathing or swallowing (which may require treatment right away), and rash; alterations in some laboratory blood tests; liver problems; inflammation of the pancreas; nausea; gallstones; inflammation of the gallbladder.

Tell your doctor if you are having these or any other medical problems while on VYTORIN. This is not a complete list of side effects. For ■ complete list, ask your doctor or pharmacist.

General Information about VYTORIN

Medicines are sometimes prescribed for conditions that are not mentioned in patient information leaflets. Do not use VYTORIN for a condition for which it was not prescribed. Do not give VYTORIN to other people, even if they have the same condition you have. It may harm them.

This summarizes the most important information about VYTORIN. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about VYTORIN that is written for health professionals. For additional information, visit the following web site: vytorin.com.

Inactive ingredients:

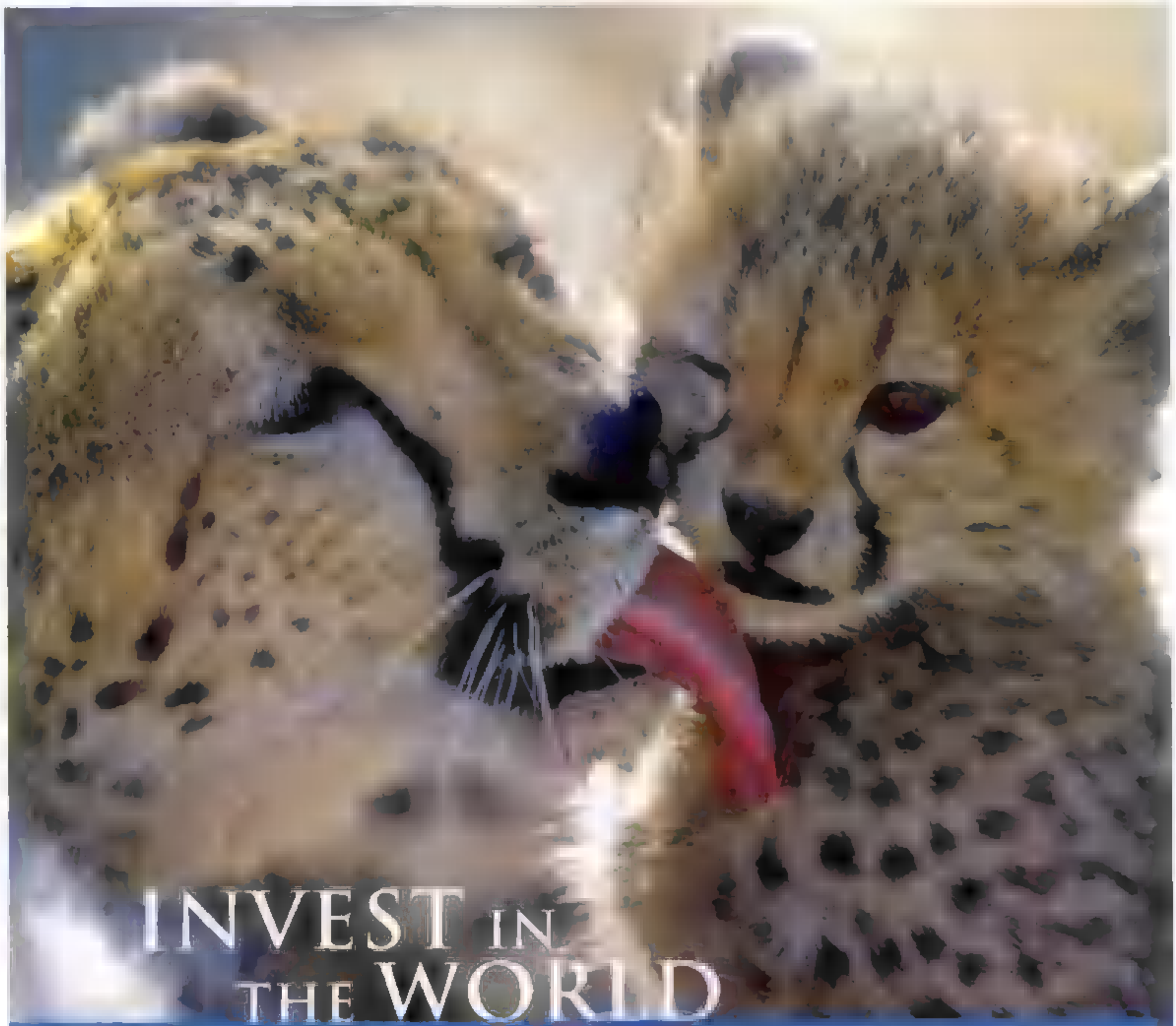
Butylated hydroxyanisole NF, citric acid monohydrate USP, croscarmellose sodium NF, hydroxypropyl methylcellulose USP, lactose monohydrate NF, magnesium stearate NF, microcrystalline cellulose NF, and propyl gallate NF.

Issued November 2004

MERCK / Schering-Plough Pharmaceuticals

Manufactured for:
Merck/Schering-Plough Pharmaceuticals
North Wales, PA 19454, USA

20550483(2)(002)-VYT



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For more information, please contact the Office of Gift Planning.

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80	8.0%	$800	$4,585.20
90	11.3%	$1,130	$5,556.80

*For illustrative purposes only. Rates are recommended by the American Council on Gift Annuities, effective 7/03. Please check for rates for more than one annuitant. *Tax deductions will vary according to date and amount of gift. Always consult your advisers about philanthropic gifts.*

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ON ASSI

ON THE ROAD IN THE FIELD

INSIDE [illegible] ADVICE

A Twist in Time

A tornado chaser catches his quarry

While his red probe's cameras shot an insider's view of a tornado last June, research engineer **Tim Samaras**, at right, caught the tornado on videotape from a safe spot down the road. Later he returned with photo assistant **John LaVere**, left, for this shot using a still from the video as a backdrop.

Samaras's live rendezvous with the tornado was slightly more challenging. His team drove 350 miles searching for a storm. As the funnel formed, they rushed to intercept it. With the tornado just a few minutes away, Samaras had to adjust the probe's position. "I moved it 40 feet to the north and said, 'Hey, time to go!'"

ROBERT CLARK

GNMENT

COVERING THE WORLD

WORLDWIDE

PHILIPPE PLAILLY EURELIOS

KING TUT

Judging from the new CT scans of the famous pharaoh, Tutankhamun had quite a distinctive look. To translate the scanning data into ■ likeness of the boy king, senior editor for art **Chris Sloan** turned to a team of specialists that included Jean-Noël Vignal, a forensic anthropologist. Jean-Noël used measurements of Tut's cranial features to calculate the tissue depth of his cheeks, nose, lips, and chin. It seems the boy king had a major overbite, a mildly cleft palate, and ■ long, flat head.

But the data only tell part of the story. The evidence "is insufficient to determine if Tut's eyes were green or brown, the hair short or long," says paleo-artist **Elisabeth Daynès** (above, with the model she created for this month's cover). First, using the data, a cast was made of Tut's skull. Elisabeth then fleshed out his features with clay before crafting the final silicone model. To style his make-up, she relied on two wooden statues found in his tomb and a limestone bust of Queen Nefertiti. Egyptologists suggested the pieces because they believe the sculptures convey the elaborate makeup worn by ancient Egyptian royals more accurately than do their highly stylized portraits. Elisabeth and photographer **Kenneth Garrett** also adorned the bust of the young pharaoh with jewelry inspired by the pieces found in Tut's tomb.

Another team has made its own model of Tut using the same CT-scan information Elisabeth used. See how the models compare at *nationalgeographic.com/magazine/0506*.

CSÁNGÓS

"I saw cows trying to cover their ears with their hooves," says photographer **Tomasz Tomaszewski** of his impromptu violin performance. He'd traded his camera for ■ violin during ■ festival in the village of Şomuşca while covering Romania's Csángó people. Tomasz was drawn to the Csángós' rich folk music traditions but found gaining access to their daily lives difficult. "A mile from the highway you enter something that looks like a scene from the 18th century. They are not used to foreigners at all," he says. He spent days simply hanging around, talking with villagers, and not taking pictures. "The challenge," he says, "was to create trust."

WEATHER FORECASTING

Shooting ■ story on weather can have its sunny side. In Turin, Italy, photographer **Jay Dickman** visited vineyards in the name of work. Later Jay, an avid skier, found himself schussing down an Austrian mountain accompanied by members of the Italian women's ski team. "I found out that it's hard to look cool on skis, heading down a near-vertical drop, when you've got a neck full of camera equipment," he notes.

Jay also went looking for menacing weather—and found it. Covering blizzard preparations at Denver International Airport, he perched 40 feet up on a cherry picker to photograph airplane de-icing sprayers through curtains of blowing snow. "One of my cameras got de-iced by the spray," says Jay. The chemicals decommissioned the camera, he adds, "but we got the shot." It's on pages 106-107.

TALES FROM THE FIELD

Find more stories from our contributors, including their best, worst, and quirkiest *experiences, in Features* at **nationalgeographic.com/magazine/0506.**

EMERGING EXPLORER CONSTANZA CERUTI High atop a remote Andean mountain, Constanza Ceruti is the first person to breathe this frigid thin air since the Inca worshipped here 500 years ago. The only woman among the world's handful of high-altitude archaeologists, she has climbed and performed research and excavation on more than 100 peaks topping 16,500 feet. Weaving together historical accounts, clues from the landscape, and ceremonial artifacts, Constanza reconstructs the spiritual life of a vanished empire.

Uncovering sacred secrets above the clouds

"IT'S VERY MOVING TO ENTER A SACRED PLACE where you know the last human footsteps were those of Inca priests. My explorations and lab work can re-create what these ancient sites looked like in great detail, the symbolic meaning behind each artifact, and how ceremonies took place. Bringing tangible remains of the past alive again also helps ensure these areas will be protected—my chance to give something back to the mountains. For me, understanding historical context lets us better explain things that happen today. Even after carrying a backpack that's half my body weight, being up there is [illegible] spiritually."


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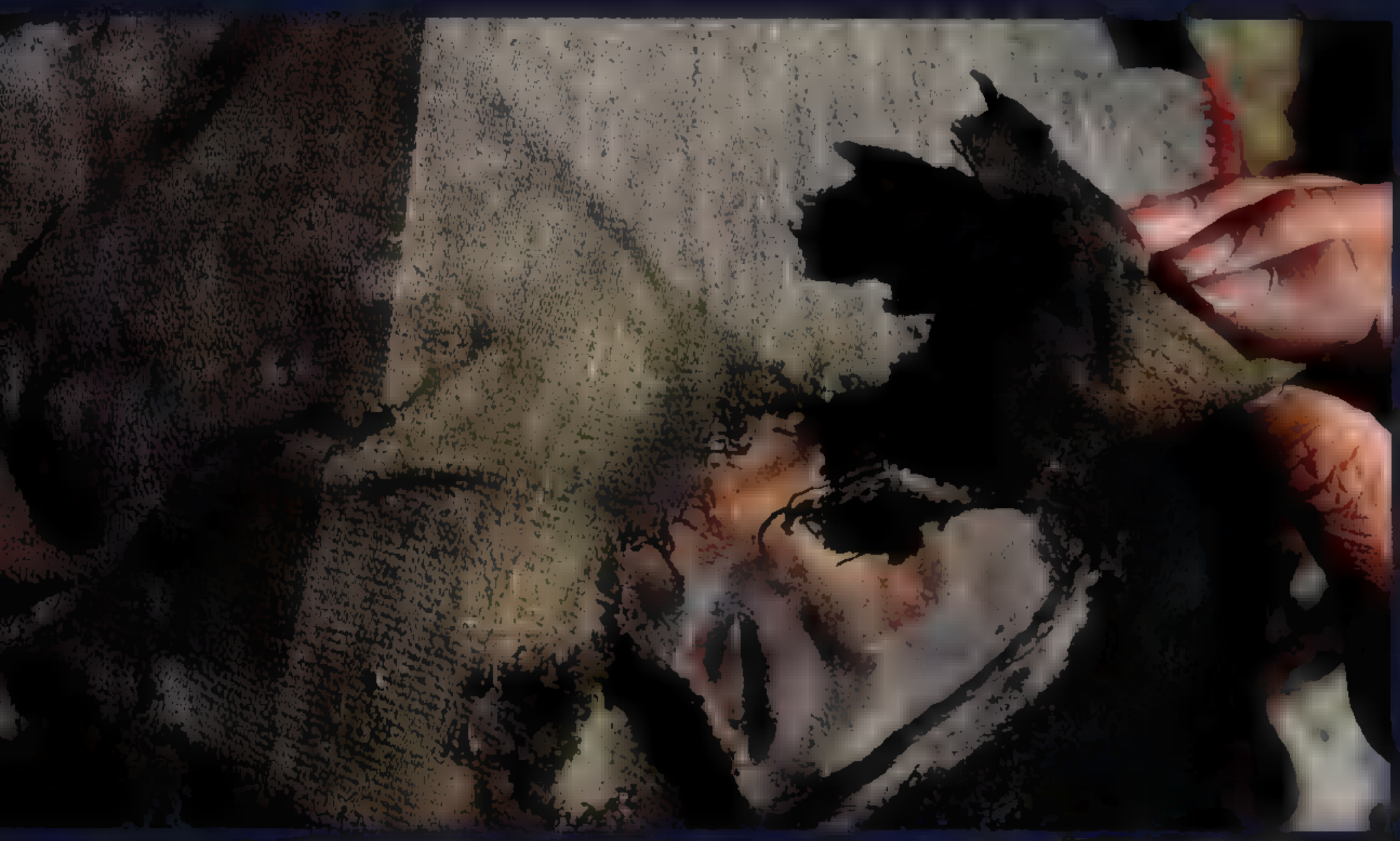
You should have the
When business speaks a global
and we believe technology can
that brings companies closer
their


Microsoft

EMERGING EXPLORERS PROGRAM

"When you are privileged to see a mummy face-to-face, it's no longer just an archaeological find, it's like meeting somebody—a bridge to the past." With hair still visible on the arms and a feather headdress perfectly intact, the world's three best preserved mummies were an unprecedented discovery. Braving driving snow and 70-mile-an-hour winds, Constanza co-led the 1999 expedition that unearthed the trio, frozen for half a millennium on the 22,100-foot summit of Llullaillaco volcano.



Since 2003, the National Geographic Emerging Explorers program has identified and supported rising talents who are pioneering discoveries in a wide range of fields. Recognizing the crucial role technology plays in exploration, Microsoft has supported this program since its inception and is proud to continue its commitment to helping an extraordinary new generation of explorers realize its potential.

Your potential. Our passion.
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NATIONAL GEOGRAPHIC
Mission Programs

EMERGING EXPLORERS

LOOKING AHEAD

Constanza is drawn to explore mountains on other continents, comparing sacred landscapes and ancient cultures around the world. Immersed in unfamiliar places, she hopes to gain perspectives that will enlighten and expand her research back home.

Visit nationalgeographic.com/emerging to see and hear the Emerging Explorers.

Photographs: Maria Stenzel

Who Knew?

PLANETARY GEOLOGY

Tilt!

Putting earthquakes in the scheme of things

Earthquakes are common around the world, but once in a while there is one so violently destructive that the usual magnitude scale seems inadequate. Thus, after December's earthquake in the Indian Ocean—and the resulting tsunami that claimed more than 200,000 lives—the scientific community offered up a believe-it-or-not of sorts: This quake changed the Earth's rotation and caused the planet to wobble on its axis.

You might picture the planet in space, jolting, lurching, as though someone had pushed in a clutch and changed gears. But in fact, in the greater scheme of things planetary, the effects of the earthquake were slight. Instruments did not even detect them directly.

In such cases scientists turn to computer models. Richard Gross, a geophysicist at the NASA Jet Propulsion Laboratory in Pasadena, used a model to calculate the effects of the earthquake on the planet.

The model assumed that the earthquake shoved a certain amount of mass toward the center of Earth as the edge of one crustal plate subducted under another. With more mass closer to the center, the planet would rotate faster, just as a spinning ice skater who pulls in her arms starts to spin so fast she becomes a blur.

Gross's model showed that the shift of mass shortened the day by 2.676 millionths of a second. But remember that's just a computer prediction.

Gross also calculated a change in one of the peculiar wobbles of the Earth. The planet, as everyone knows, spins on an axis. This line is called the rotation axis. But the planet's mass is balanced around a different line: the figure axis, a line that passes precisely through the center of the Earth. There's a slight discrepancy between the positions of the two axes (which translates to a distance of about 33 feet at the North Pole), and the difference makes the Earth act much like a wobbly tire on a car that needs to go to the shop. According to Gross's calculation, the December earthquake shifted the figure axis (and thus the Earth's wobble) by about one inch.

The bigger lesson here is that earthquakes, no matter how individually destructive, are part of a larger reality: an elaborate tectonic system that helps make life possible. Subduction of Earth's plates is essential to the recycling of carbon—and it appears to be no coincidence that the only object in the solar system known to support life is also the only object with tectonic activity. Mars, for example, has no tectonic plates, no earthquakes, and appears to be a cold, airless, lifeless planet. The long, fruitful existence of a biosphere may require that a planet be dynamic—and sometimes tragically violent.

—Joel Achenbach
WASHINGTON POST STAFF WRITER

PHOTO ILLUSTRATION BY CARY WOLINSKY

Days of Our Lives

As long as humans have lived on Earth, the day has been 24 hours long. But humans are just a blip in the history of the planet. Not long after the Earth formed more than four billion years ago, a day was less than ten hours long. Four hundred million years ago there were 400 22-hour days in a year.

Why the changes? Earthquakes, hurricanes, ice ages, even El Niño have an effect. But the greatest influence comes from tidal friction, or gravitational forces between Earth and the moon. Tidal friction causes the planet to spin more slowly, so that our day is getting longer by 20 seconds every million years. No need to adjust your clock anytime soon. *—Heidi Schultz*

WEBSITE EXCLUSIVE For more about Earth's rotation, and for links to Joel Achenbach's work, go to Departments at **nationalgeographic.com/magazine/0506.**

MODERN TECHNOLOGY REOPENS THE ANCIENT CASE OF

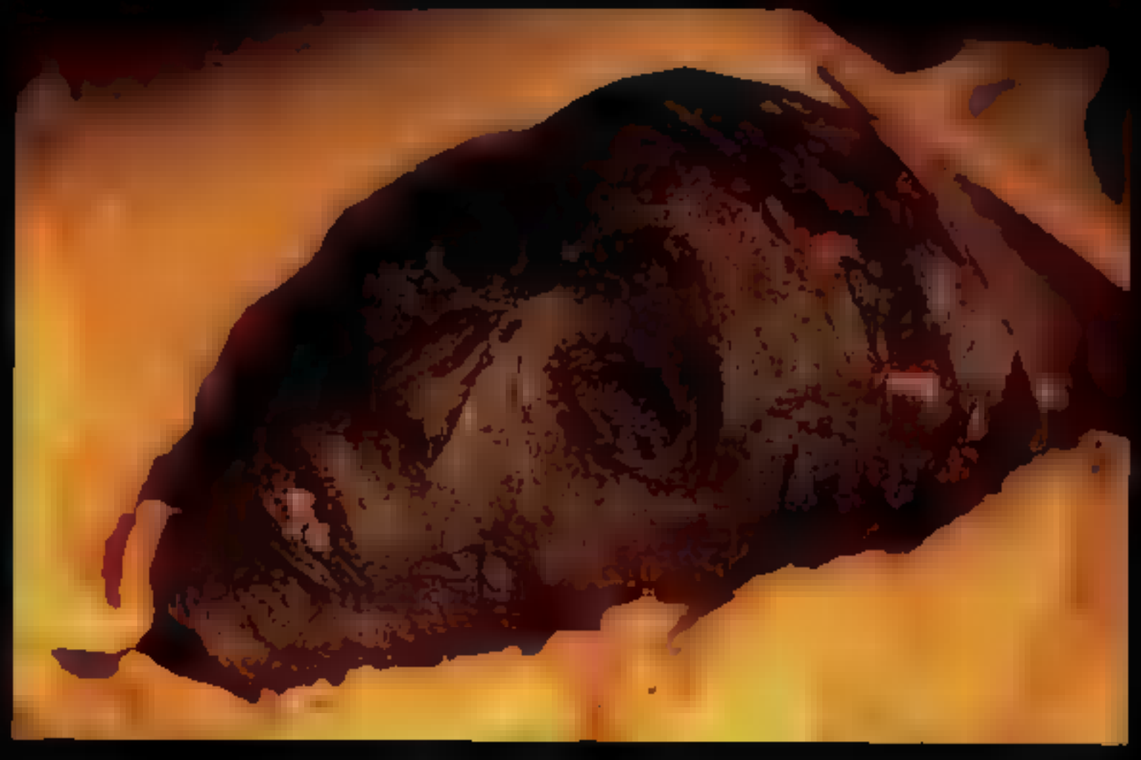
KING TUT

BY R. WILLIAMS
NATIONAL GEOGRAPHIC SENIOR WRITER

PHOTOGRAPHS BY KENNETH GARRETT

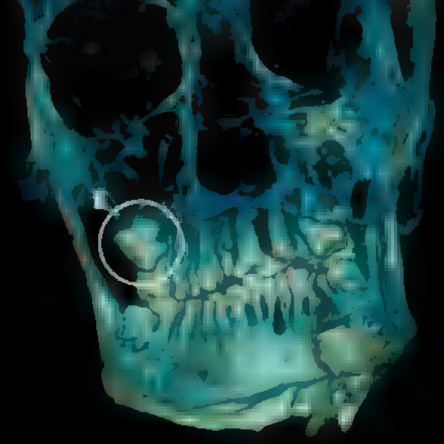
He was just a teenager when he died. The last heir of a powerful family that had ruled Egypt and its empire for centuries, he was laid to rest laden with gold and eventually forgotten. Since the discovery of his tomb in 1922, the modern world has speculated about what happened to him, with murder the most extreme possibility. Now, leaving his tomb for the first time in almost 80 years, Tut has undergone a CT scan (above) that offers new clues about his life and death—and provides precise data for an accurate forensic reconstruction (right) of the boyish pharaoh.

INSIDE KING TUT'S subterranean burial chamber, against a backdrop of sacred murals, Zahi Hawass, head of Egypt's Supreme Council of Antiquities, removes padding to reveal the young pharaoh's remains. "When I saw his face, I was shocked," says Hawass. "My heart was pounding, and I could not speak." Moments later, workmen carried the mummy—still in the plain wooden box where British archaeologist Howard Carter placed it decades ago—to a trailer parked at the entrance of the tomb. There, a CT machine scanned the mummy head to toe, creating 1,700 digital x-ray images in cross section. Tut's head (below), scanned in .62-millimeter slices to register its intricate structures, takes on eerie detail in the resulting image (far right). With Tut's entire body similarly recorded, a team of specialists in radiology, forensics and anatomy began to probe the secrets that the winged goddesses of a gilded burial shrine (foldout pages) protected for so long.



CT IMAGE AT RIGHT: CT SCANNING EQUIPMENT PROVIDED BY SIEMENS AG; DATA COURTESY THE SUPREME COUNCIL OF ANTIQUITIES, ARAB REPUBLIC OF EGYPT. WINGED GODDESSES: KENNETH GARRETT, EGYPTIAN MUSEUM, CAIRO

WHAT KILLED KING TUT?



CLUES FROM TOP...

Did the young pharaoh die from a blow to the head? Definitely not, say the nine doctors who studied the CT images. Some Egyptologists and amateur sleuths have long speculated that a stealthy foe murdered Tut by attacking him from behind. As evidence, they cite an x-ray taken in 1968 (inset), which shows a fragment of bone (A) in the skull cavity—emptied by embalmers, according to custom. The CT scan, however, found no trace of lethal trauma to the head. A cross section reveals two loose pieces of bone (B and C), as well as additional chips embedded in the embalming resins that line the top and back of the skull. Packing material also appears near the ear canals and in the sinus cavities, and plugs close the nostrils. To remove the brain, pour in the resins—at two separate times—and stuff in the packing, the embalmers apparently entered the skull through the nose and tore the neck (D), perhaps breaking off bone in the process. Carter's handling of the mummy may also have produced bone fragments.

The maturity of the skeleton and wisdom teeth (E, one circled) confirms that Tut was about 19 years old when he died. His teeth had no cavities, and though his palate had a small cleft, he was probably unaware of it. The elongated shape of his skull—similar to that of other family members—was not caused by disease and falls within the range of normal variation.

...TO BOTTOM

About five feet [illegible] inches tall and slightly built, Tut was in excellent health—well fed and free of any disease that would have affected his physique. Though his spine appears curved (right), it was probably misaligned during embalming. Something out of the ordinary, then, must have struck him down. But what? The experts can't say for sure because of the difficulty in distinguishing between possible injuries to Tut while alive and the damage Carter's team did to the mummy. Some believe, for instance, that a fracture above the left knee (inset, below) was Carter's fault. Others think it may be the result of an accident or assault that led to Tut's demise after a virulent infection set in and spread.

Tut's funerary equipment—including chariots, bows, arrows, and throwing sticks—indicates that he had learned to hunt and fight like a proper pharaoh. In addition, a painted wooden box (above) shows him defending Egypt from its enemies, a symbolic scene but maybe based in truth. Could he have died in battle? Or might he have crashed his chariot while hunting?

Supporters of such possibilities point to Tut's mangled chest (above left), with its breastbone missing and much of the front rib cage cut out. Carter's anatomist notes that resin-soaked linen packed in Tut's chest prevented an examination—so the bones were likely not removed at that time. Did the embalmers take them out while preparing a gravely injured Tut for eternity? It's an intriguing question, but for now the pharaoh is still keeping some secrets.

MAGNIFY THE KING Zoom in on parts of Tut's skeleton, see additional CT images, and learn more about what the scans reveal at nationalgeographic.com/magazine/0506.

CT SCANNING EQUIPMENT PROVIDED BY SIEMENS AG; DATA COURTESY SUPREME COUNCIL OF ANTIQUITIES, ARAB REPUBLIC OF EGYPT. DIGITAL COMPOSITE AND COLORATION BY NGM ART. PHOTOGRAPH OF DIGITIZED COPY OF R. G. HARRISON 1968 X-RAY: R. J. CONNOLLY, UNIVERSITY OF LIVERPOOL. WOODEN BOX: KENNETH GARRETT, EGYPTIAN MUSEUM, CAIRO

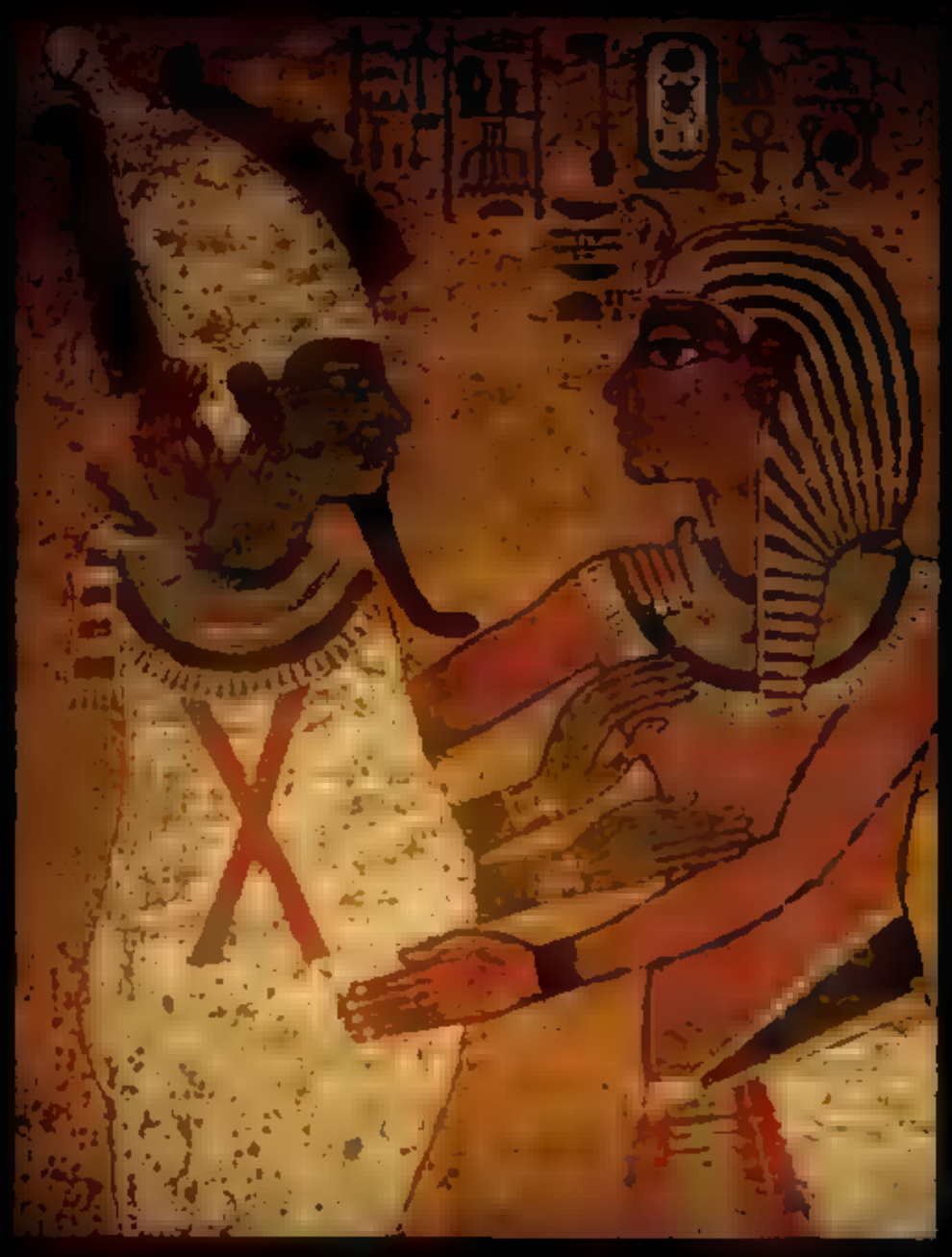
SPLENDOR OF THE INNER SANCTUM

Carved into the Valley of the Kings, Tut's tomb hid his mummy and funerary regalia until archaeologist Howard Carter revealed its contents to world acclaim. Though the peripheral rooms were looted in antiquity, the burial itself remained untouched. The layered treasures included four nested boxes, or shrines, of gilded wood (cascading from top left), then three mummy-shaped coffins—two gilded and one of solid gold—all inside a red quartzite sarcophagus. At the center rested Tut himself, with a stunning mask of gold covering his head and shoulders.

▶ **UNPACK TUT'S TOMB** using a three-dimensional animation at nationalgeographic.com/magazine/0506.

ART BY DAMNFX


Tomb of
Tutankhamun



GUIDE TO THE GREAT BEYOND

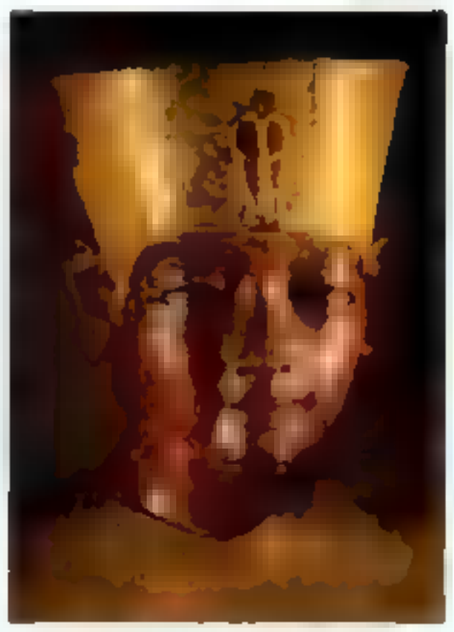
Scenes infused with magical powers surround Tut's burial chamber and map out his journey to the next world. After the funeral procession, his successor, Aye, symbolically revives the dead king (far right). Nut, the sky goddess (third from right), welcomes Tut to the realm of the gods, and Osiris, god of the afterlife, embraces him (above) along with his *ka*, or spiritual double (fourth from right). Baboons on the far wall represent the start of his passage through the 12 hours of the night—a journey symbolized by a boat bearing a scarab, emblem of the sun god.

▶ **THE ARTFUL DEAD** Examine the murals in King Tut's tomb inch by inch and learn more about the story they tell at nationalgeographic.com/magazine/0506.

ART BY DAMNFX

DISCOVERING TUT: THE SAGA CONTINUES

An angry wind stirred up ghostly dust devils as King Tut was taken from his resting place in the ancient Egyptian cemetery known as the Valley of the Kings. Dark-bellied clouds had scudded across the desert sky all day and now were veiling the stars in casket gray. It was 6 p.m. on January 5, 2005. In a few moments the world's most famous mummy would glide headfirst into a CT scanner brought here to probe the lingering medical mysteries of this little understood young ruler who died more than 3,300 years ago.



All afternoon the usual line of tourists from around the world had descended into the cramped, rock-cut tomb some 26 feet underground to pay their respects. They gazed at the murals on the walls of the burial chamber and peered at Tut's gilded face, the most striking feature of his mummy-shaped outer coffin lid. Some visitors read from guidebooks in a whisper. Others stood silently, perhaps pondering Tut's untimely death in his late teens, or wondering with a shiver if the pharaoh's curse—death or misfortune falling upon those who disturbed him—was really true.

When the valley closed to the public at dusk, Egyptologists in jeans and laborers in long robes and turbans got to work. Shouting directions and encouragements over the roar of fresh air being pumped into the tomb, they quickly attached ropes to the head and foot of the coffin lid and lifted it out of the sarcophagus. After a pause to reposition the ropes, they slowly pulled up a plain wooden box. Inside, cradled by cotton batting and yellowed muslin, lay the mortal remains of King Tutankhamun: a serene face with a scarred left cheek, a barrel chest, skeletal arms and legs, all blackened by resins poured on during his burial rites.

"The mummy is in very bad condition because of what Carter did in the 1920s," said Zahi Hawass, secretary general of Egypt's Supreme Council of Antiquities, as he leaned over the body for a long first look. Carter—Howard Carter, that is—was the British archaeologist who in 1922 discovered Tut's tomb after years of futile searching. Its contents, though hastily ransacked in antiquity, were surprisingly complete. They remain the richest royal collection ever found and have become part of the pharaoh's legend. Stunning artifacts in gold, their eternal brilliance meant to guarantee resurrection, caused a sensation at the time of the discovery—and still get the most attention. But Tut was also buried with everyday things he'd want in the afterlife: board games, a bronze razor, linen undergarments, cases of food and wine.

After months of carefully recording the pharaoh's funerary treasures, Carter began investigating his three nested coffins. Opening the first, he found a shroud adorned with garlands of willow and olive leaves, wild celery, lotus petals, and cornflowers, the faded evidence of a burial in March or April. When he finally reached the mummy, though, he ran into trouble. The ritual resins had hardened, cementing Tut to the bottom of his solid gold coffin. "No amount of legitimate force could move them," Carter wrote later. "What was to be done?"

The sun can beat down like a hammer this far south in Egypt, and Carter tried to use it to loosen the resins. For several hours he set the mummy outside in blazing sunshine that heated it to 149 degrees Fahrenheit. Nothing budged. He reported with scientific detachment that "the consolidated material had to be chiseled away from beneath the limbs and trunk before it was possible to raise the king's remains."

In his defense, Carter really had little choice. If he hadn't cut the mummy free, thieves most certainly would have circumvented the guards and ripped it apart to remove the gold. In Tut's time the royals were fabulously wealthy, and they thought—or hoped—they could take their riches with them. For his journey to the great beyond, King Tut was lavished with glittering goods: precious collars, inlaid necklaces and

KENNETH GARRETT, EGYPTIAN MUSEUM, CAIRO (INSET OF TUT)

When the young ruler of Egypt's far-reaching empire died unexpectedly, a courtier's cramped, unfinished tomb was appropriated for the king. It lies across the Nile from the ancient city of Thebes, now Luxor and Karnak, in a necropolis at the edge of the Western Desert, the place of death in antiquity.

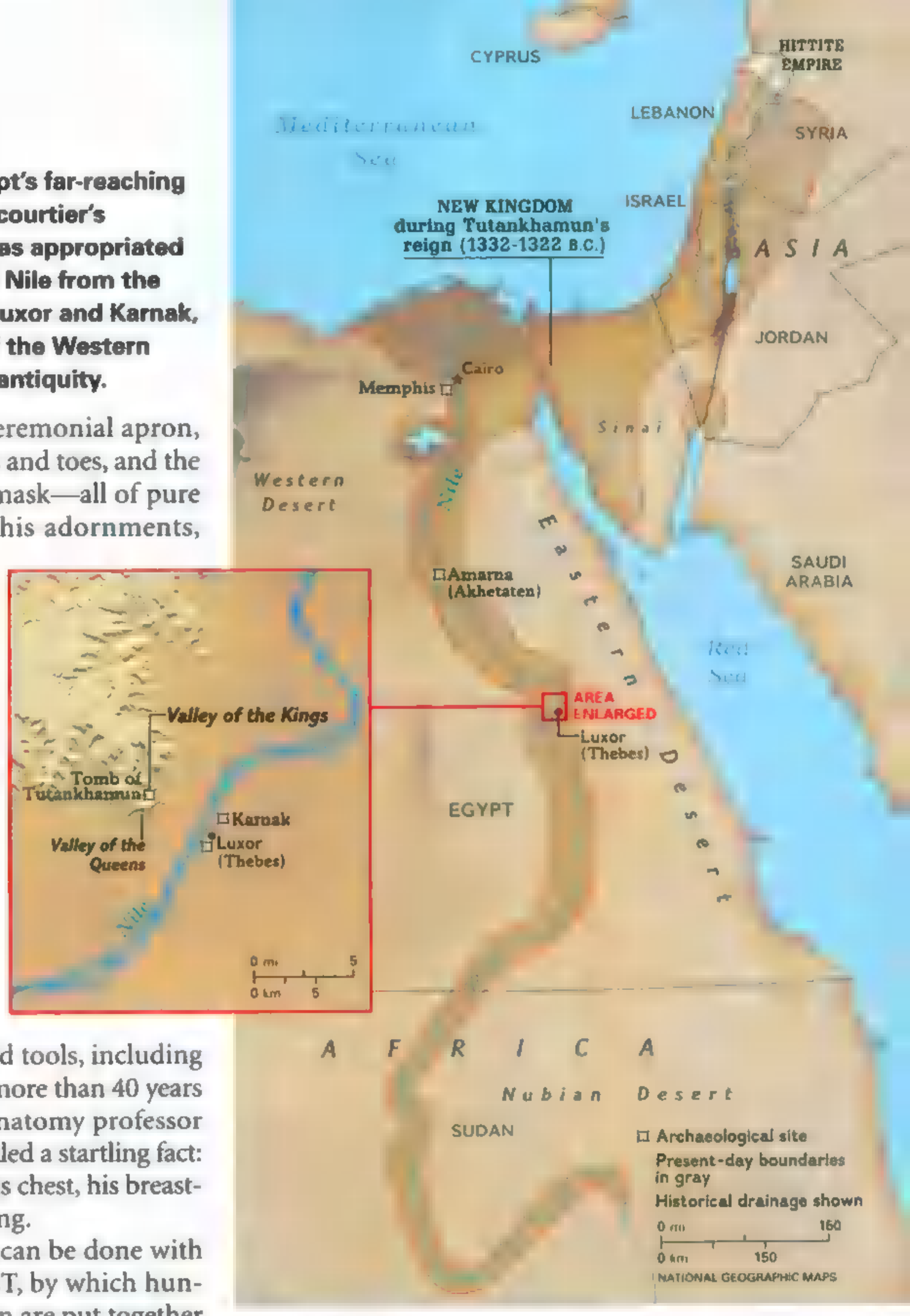
bracelets, rings, amulets, a ceremonial apron, sandals, sheaths for his fingers and toes, and the now iconic inner coffin and mask—all of pure gold. To separate Tut from his adornments, Carter's men removed the mummy's head and severed nearly every major joint. Once they had finished, they reassembled the remains on a layer of sand in a wooden box with padding that concealed the damage, the bed where Tut now rests.

Archaeology has changed substantially in the intervening decades, focusing less on treasure and more on the fascinating details of life and intriguing mysteries of death. It also uses more sophisticated tools, including medical technology. In 1968, more than 40 years after Carter's discovery, an anatomy professor x-rayed the mummy and revealed a startling fact: Beneath the resin that cakes his chest, his breastbone and front ribs are missing.

Today diagnostic imaging can be done with computed tomography, or CT, by which hundreds of x-rays in cross section are put together like slices of bread to create a three-dimensional virtual body. What more would a CT scan reveal of Tut than the x-ray? And could it answer two of the biggest questions still lingering about him—how did he die, and how old was he at the time of his death?

King Tut's demise was a big event, even by royal standards. He was the last of his family's line, and his funeral was the death rattle of a dynasty. But the particulars of his passing and its aftermath are unclear. "This period is like a play," Zahi Hawass explained in his busy Cairo office before the scan. "A part of this play is written. But the final scenes are not known."

These things we do know: Amenhotep III—Tut's father or grandfather, depending on how you read the evidence—was a powerful pharaoh who ruled for almost four decades at the height of the 18th dynasty's golden age. His son Amenhotep IV succeeded him and initiated one of the strangest periods in the history of ancient Egypt. The new pharaoh promoted the worship of the Aten, the sun disk, changed his name to Akhenaten, or "servant of the Aten," and moved the religious capital from the old city of Thebes to the new city of Akhetaten, known now as Amarna. He further shocked the country by attacking Amun, a major god, smashing his images and closing his temples. "It must have been a horrific time," said Ray Johnson, director of



AMENHOTEP III
1390–1353 B.C.*
Tut's father or grandfather, ruled a vast empire

QUEEN TIYE
1390–1340 B.C.
Amenhotep III's chief wife, Akhenaten's mother

AKHENATEN
1353–1336 B.C.
Abandoned the old religion to worship the Aten, or sun disk

QUEEN NEFERTITI
1352–1340? B.C.
Akhenaten's chief wife, mother of six daughters, no sons

FAMILY...FRIENDS...FOES?

*DATES INDICATE YEARS OF REIGN

the University of Chicago's research center in Luxor, the site of ancient Thebes. "The family that had ruled for centuries was coming to an end, and then Akhenaten went a little wacky."

After Akhenaten's death, a mysterious ruler named Smenkhkare appeared briefly and exited with hardly a trace. And then a very young Tutankhaten took the throne—King Tut as he's widely known today. The boy king soon changed his name to Tutankhamun, "living image of Amun," and oversaw a restoration of the old ways. He reigned for about nine years—and then died unexpectedly.

A crisis of succession gripped the royal court. With power plays and intrigues surely seething around her, Tut's widow, Ankhesenamun, appears to have launched a coup of her own, sending desperate letters to the king of the Hittites in Anatolia. "My husband is dead," she wrote. "Send me your son and I will make him king." It was an unprecedented request, but understandable. "Her grandmother was Queen Tiye, one of the most powerful queens Egypt ever saw," Ray Johnson explained. "Her mother was Nefertiti. They ruled as living goddesses, so of course Ankhesenamun felt she had the same power. And she found out that she didn't."

A Hittite prince, Zannanza, was eventually sent south to marry her, but he was killed—by a hit squad, some speculate—as he entered Egyptian territory. An elder courtier named Aye, possibly Ankhesenamun's grandfather, then became pharaoh. Was he an honorable official who stepped into the top job in the sudden absence of an heir? Or did he callously plot Tut's death for his own advantage? Either way, he reigned for only three or four years. When he died, army commander Horemheb took control.

The new ruler, a man of great ambition, had risen to the throne from obscure beginnings. Did he conspire with the aged Aye to eliminate Tut and the Hittite prince, and then bide his time until Aye's death? He had the motive, the opportunity, and the power. In any event Horemheb, still sadly childless late in his reign, named as crown prince his old army buddy Ramses, who became the founder of a new dynasty.

Egyptologists put little stock in conspiracy theories, but tales of intrigue have captured the imagination of countless King Tut sleuths, who cite the circumstantial evidence against Aye, Horemheb, and even Tut's wife, Ankhesenamun, as well as clues from the burial. For starters, Tut's tomb is unusually small for a king, and its contents were crammed in. Carter noted that the nested shrines surrounding the sarcophagus "had obviously been banged together, regardless of the risk of damage." In addition, workmen had hacked at the mummy-shaped outer coffin to make it fit into the sarcophagus. These factors, and more, make a litany of haste—but do they testify to murder?

King Tut could easily have succumbed to an infection or illness. Letters from that era record

that a plague—as yet unidentified—ravaged Egypt and its neighbors. An accident is another possibility. It's easy to imagine Tut at the reins of a chariot feeling a young man's need for speed. He hits a bump, flies through the air, and lands with a deadly crunch. Could such a fall have damaged his breastbone and ribs so badly that the embalmers had to remove them?

Regardless of his fame and the speculations about his fate, Tut is one mummy among many in Egypt. How many? No one knows. The Egyptian Mummy Project, which began an inventory in late 2003, has recorded almost 600 so far and is still counting. The next phase: scanning the mummies with a portable CT machine donated by the National Geographic Society and Siemens, its manufacturer. King Tut is one of the first mummies to be scanned—in death, as in life, moving regally ahead of his countrymen.

The night of the scan, workmen carried Tut from the tomb in his box. Like pallbearers they climbed a ramp and a flight of stairs into the swirling sand outside, then rose on a hydraulic lift into the trailer that held the scanner. Twenty minutes later two men emerged, sprinted for an office nearby, and returned with a pair of white plastic fans. The million-dollar scanner had quit because of sand in a cooler fan. "Curse of the pharaoh," joked a guard nervously.

Eventually the substitute fans worked well enough to finish the procedure. After checking that no data had been lost, the technicians turned Tut over to the workmen, who carried him back to his tomb. Less than three hours after he was removed from his coffin, the pharaoh again rested in peace where the funerary priests had laid him so long ago.

Back in the trailer a technician pulled up astonishing images of Tut on a computer screen. A gray head took shape from a scattering of pixels, and the technician spun and tilted it in every direction. Neck vertebrae appeared as clearly as in an anatomy class. Other images revealed a hand, several views of the rib cage, and a transection of the skull. Analysis by a team of radiologists would take several weeks to complete—and would reveal no conclusive evidence for murder. But for now the pressure was off. Sitting back in his chair, Zahi Hawass smiled, visibly relieved that nothing had gone seriously wrong. "I didn't sleep last night, not for a second," he said. "I was so worried. But now I think I will go and sleep."

By the time we left the trailer, descending metal stairs to the sandy ground, the wind had stopped. The winter air lay cold and still, like death itself, in this valley of the departed. Just above the entrance to Tut's tomb stood Orion—the constellation that the ancient Egyptians knew as the soul of Osiris, the god of the afterlife—watching over the boy king.

DO NOT DISTURB THE DEAD? Does respect for ancient remains preclude scientific study? Share your view in our online forum, plus visit a gallery of Tut images and find links to more resources at **nationalgeographic.com/magazine/0506.**

TREASURES OF A GOLDEN AGE

Tut's throne (left) shows a rare intimate scene: his wife rubbing him with perfumed oil. For the first time since 1981 some of the masterpieces from his tomb are now on tour. "Tutankhamun and the Golden Age of the Pharaohs," a National Geographic exhibition, opens June 16 in Los Angeles and includes his diadem, gilded statues, and an alabaster cup inscribed with hieroglyphs that read: "... may you, who love Thebes, spend millions of years with your face to the north wind, and may your eyes see joy." ▯

ANDREAS F. VOEGELIN, EGYPTIAN MUSEUM, CAIRO (DIADEM); KENNETH GARRETT, EGYPTIAN MUSEUM, CAIRO

Why can't we Chesa

Into the mist, a waterman works a trotline for crabs on Maryland's Patuxent River. Yet another push to clean such tributaries may be the bay's best hope.

save the bay?

By TOM HORTON Photographs by PETER ESSICK

peake

Twice as many people live

Even as commercial fisheries plummet, the bay and its tributaries have grown into major playgrounds for area residents. Recreational boaters like the Battle Creek Gang (below), here on the bank of the Patuxent River, spend an estimated two billion dollars a year in Maryland alone

and play here as in 1950 . . .


. . . and their pollution

is choking the bay.

A good punt from the Baltimore Ravens' stadium, three highways converge over a branch of the Patapsco River, one of the most polluted waterways in [illegible]. Local efforts to restore the area, plagued by sewage spills and trash, haven't cleaned up the mess.

It's a moonless February evening, heavy sleet and snow on the way, winds 15 knots and gusting, building a sharp chop on Chesapeake Bay. "Looks good to go," says my friend Don Baugh, meaning it's time to pull on fleece insulation and dry suits, and kayak for an hour to our roost for this long winter's night. We're headed for an uninhabited dab of marsh and dune, miles from the nearest mainland, with just enough lee from the oncoming blow to shelter a campfire. Waves slap a glaze of ice on our foredecks as we paddle through the splash and black.

Soon, under a tarp staked in the wind shadow of a dune, we've got chunks of glowing oak, stashed in balmier times, throwing off luxurious heat, popping open fat, locally tonged oysters on a grate. The evening's musical entertainment features a nearby band of wintering tundra swans, flown in from Alaska's North Slope. Sleet rattles the tarp as the storm blots the lights of fishing villages that sparkle from the mainland.

There are comfier ways to experience Chesapeake Bay, but no truer ones for us. In the nighttime, in wintertime, we find refuge and renewal in these shrinking vestiges of the wilder Chesapeake we knew many years ago. It was much easier then to lose oneself in the countless creeks and rivers that vein the tidal bay's more than 11,600 miles of coastline, to jump black ducks from the marshes, pluck soft crabs and oysters from the clear, grassy shallows, and float on waters not constantly churned by the wake of high-speed sport boats. So much has changed—oysters nearly gone, crabs near historic lows, waterman towns dying out, buildings and roads fracturing the countryside. Population in the estuary's watershed, which includes parts of six states and the District of Columbia, has doubled in our lifetime, from 8 million to 16 million, compromising solitude as well as water quality.

No one had illusions that the work of the Chesapeake Bay Program, a massive federal-state restoration effort, begun in 1983 and unmatched anywhere in the world, would be quick or easy. But no one anticipated that 22 years later we'd still be struggling. Chesapeake Bay is not alone. From the Gulf of Mexico to Europe's Baltic and North Seas, from Hong Kong to Chile to Australia, dozens of coastal regions are showing similar declines. Not one has yet fully recovered.

"If the richest, most powerful nation on Earth can't clean up this mess on the very doorstep of the nation's capital, what message do we send for the future of the planet?" asks William C. Baker, president of the nonprofit Chesapeake Bay Foundation (CBF). Founded in 1967, and one of the largest regional environmental groups in the U.S., CBF is the voice of the Chesapeake; in its latest ecological report card CBF gave Chesapeake Bay a failing grade of 27 out of 100.

It's a time of soul-searching for people like Baugh and me, who have dedicated our careers to reversing the decline—I as a journalist, he as an environmental educator. I've known the bay for six decades, through its health and decline, blithely gloried in it as a young hunter, fisherman, and marsh mucker; worried professionally about it for 30 years as an environmental writer for the Baltimore *Sun;* and written about it "hanging in the balance" 12 years ago in this magazine.

During the past year I've been traveling the approximately 200-mile-long estuary by kayak, skiff, and back road. Call it a farewell to old haunts, or maybe a search for hope. Or maybe it's the bay writer at 60 trying to come to terms with what was supposed to happen on his watch, but may not; may never.

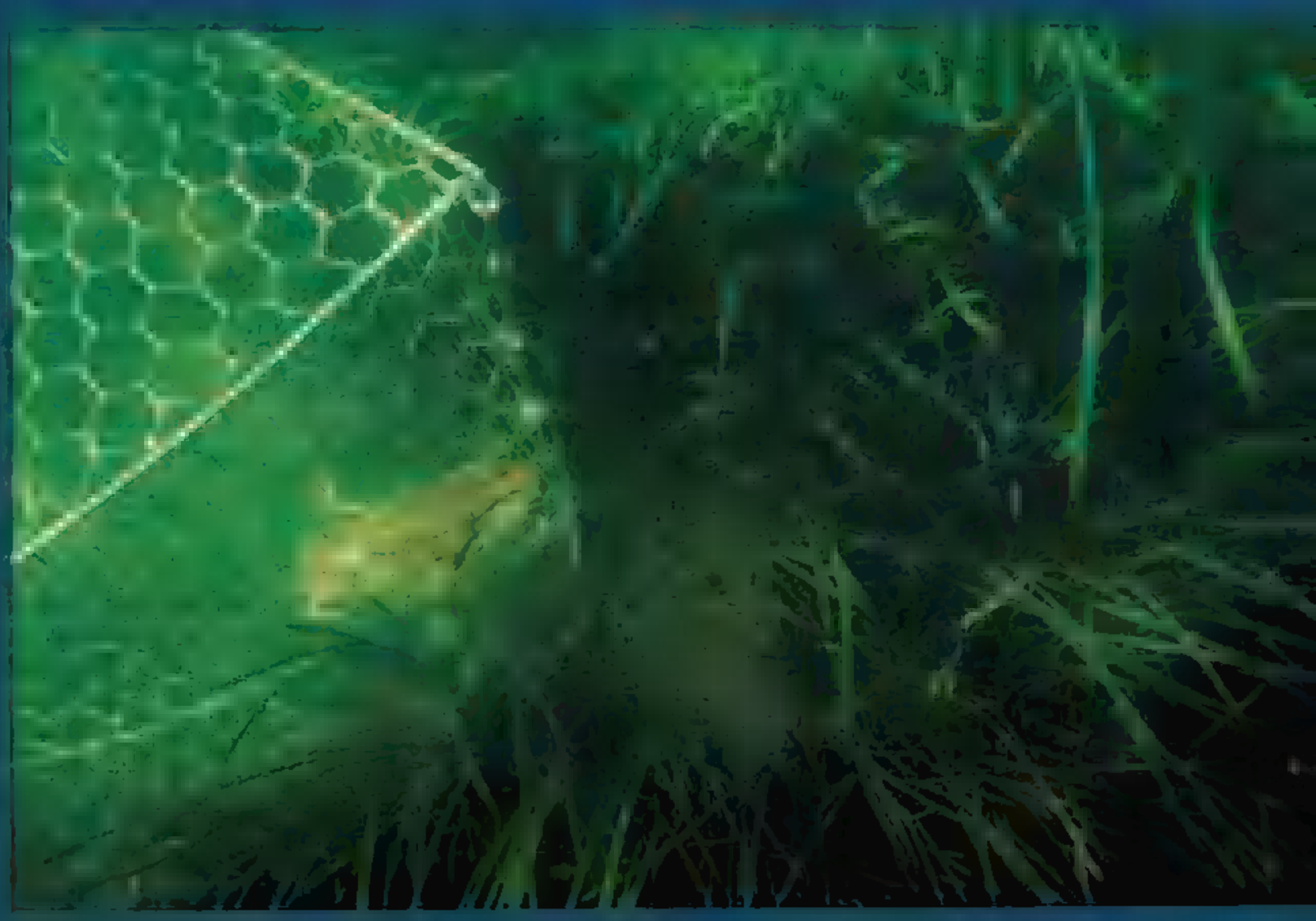
Slamming gears and sorting crabs, he

This thought weighed on me one June weekend in the fishing village of Tilghman Island on Maryland's Eastern Shore. The graceful old oyster skipjack *Rebecca T. Ruark* was ready to sail from Dogwood Harbor. I've spent cold, blowy winter days watching tons of muddy oysters being hauled aboard her battle-scarred decks. Now freshly painted, with lounge chairs on her deck, *Rebecca* never looked prettier—or more out of her element. In the decades after she was launched in 1886, a thousand wooden sailcraft worked the bay. Now she's a national historic landmark, one of a handful of surviving skipjacks largely relegated to use for recreational charters, museum exhibits, or sailing at festivals.

"I do marryin's and buryin's—scatter your ashes—I do sunset cruises, special charters, whatever people want," *(Continued on page 36)*

moves with the precision of a prizefighter.

"When the crab season starts, I'm as excited as a little boy on Christmas," says James Eskridge, Jr., of Tangier Island, Virginia, at 26 one of the few young watermen betting their futures on the bay. His future, as well as that of the bay's blue crabs, is tied to eelgrass (right) and other plants that help trap sediment and provide habitat for many species. Despite a partial comeback, bay grasses cover less than half the area they did decades ago.

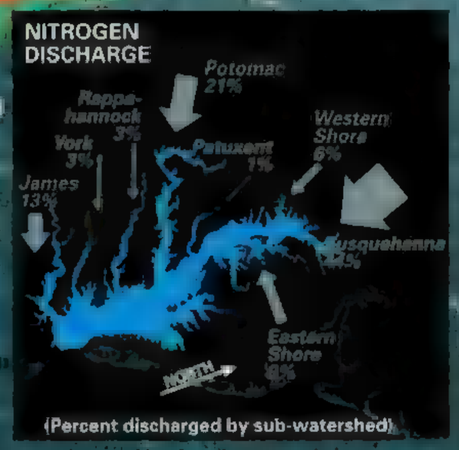


What's flushing into Chesapeake Bay?

The price of population growth

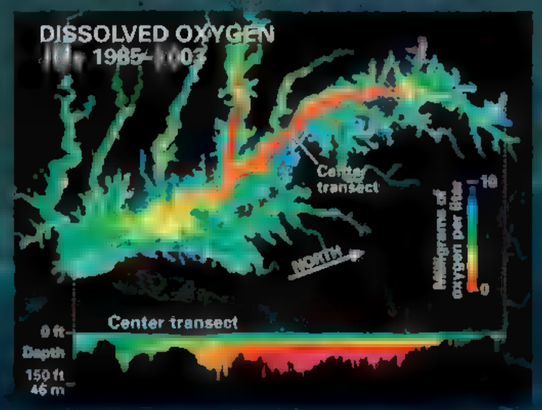
As runoff rises . . .

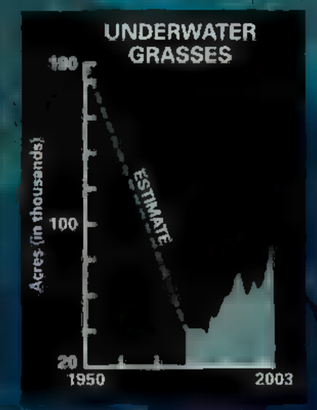
Nitrogen and phosphorus, the nutrients that spur algae growth, are by-products of modern life. Agricultural runoff, sewage plants, storm water runoff, and air pollution now pump about 18 times as much nitrogen and 20 times as much phosphorus into the bay as when John Smith explored it during the 1600s. Farms kick in nearly half the problem. Parking lots, roads, and other impervious surfaces in the watershed have grown by 41 percent over the past decade, while natural buffers like forests and wetlands are falling at more than 100 acres a day.



(Percent discharged by sub-watershed)

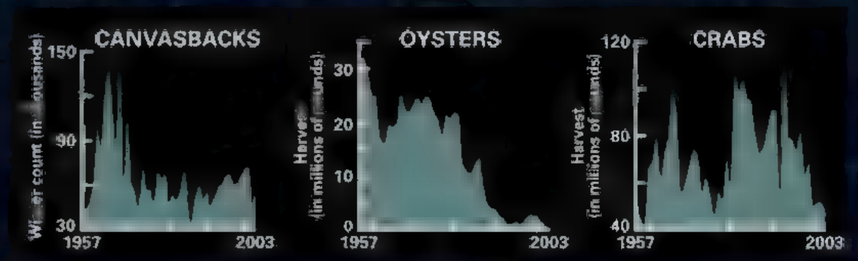
water quality declines . . .



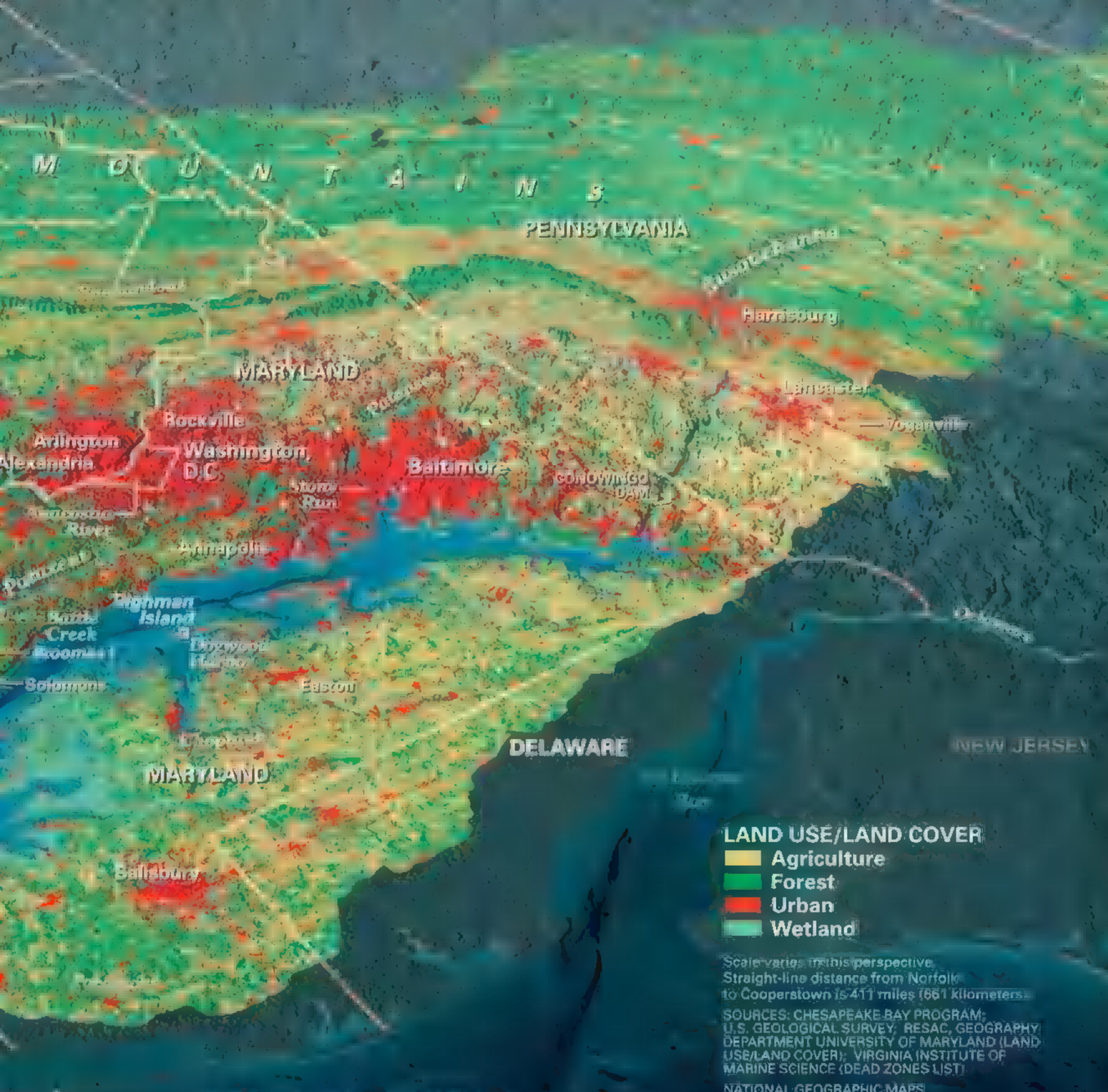


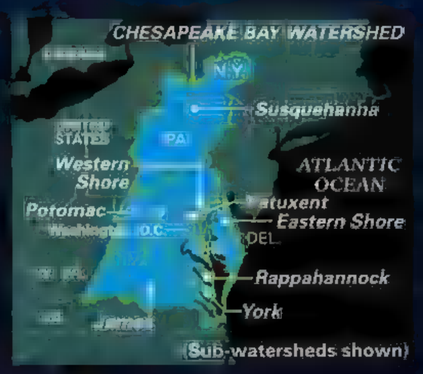
Nutrients turn algae into time bombs that explode each summer. As algae die, bacteria that feed on the algae suck oxygen from the water, making about 20 percent of the bay a deepwater dead zone. Algae and sediment also block sunlight needed for underwater grasses that provide crucial nurseries. Young crabs are up to 30 times more abundant in grass beds than on barren bottom.

and native species struggle.



Disease, loss of habitat, and water quality have hit native bay species hard. Canvasback ducks, which once depended on aquatic plants for winter survival, have declined by about half since 1957. Oysters, once able to filter the bay's entire water volume in less than a week, are now at one percent of 1950s levels, and blue crabs, the legendary bay delicacy, face continuing threats.





Born after the last glacial period, when rising sea levels flooded the Susquehanna River Valley, Chesapeake Bay is the largest estuary in the United States—and one of the most troubled. For centuries inflows of fresh water mixed with seawater through meadows of underwater grass to nurture millions of pounds of crabs, oysters, and fish each year. But the same geography that helped make the bay so productive also makes it that much harder to fix. Nutrient and sediment loads in tributaries have risen dramatically over the past half century, clouding the once clear water and fueling massive algae blooms. Scientists pin the blame on suburban sprawl and chemical-intensive agriculture in this 64,000-square-mile watershed—drainage basin for six states and the District of Columbia—as well as on a car-loving population growing by more than 100,000 people each year.

[illegible]

It's a reason as old as the U.S. can't keep waterways clean around its capital, what does that mean for other countries struggling with polluted bays and estuaries? A short list of the worst cases.

World's largest dead zones

- Baltic Sea (27,027 sq mi, 70,000 sq km)
- Northwestern Black Sea (15,444 sq mi, 40,000 sq km)
- Northern Gulf of Mexico (6,564 sq mi, 17,000 sq km)

Other degraded estuaries

- Mecklenburg Bay, Germany
- Long Island Sound, U.S.
- Hakata Bay, Japan
- Gironde Estuary, France
- Nichupte Lagoon, Mexico
- Bilbao Estuary, Spain
- Guanabara Bay, Brazil
- Venice Lagoon, Italy
- Tanshui Estuary, Taiwan
- Mobile Bay, U.S.
- Western Gulf of St. Lawrence, Canada
- Big Glory Bay, New Zealand

▶ For more data on environmental conditions in Chesapeake Bay, visit nationalgeographic.com/magazine/0506.

Virtually everything finds its way into the bay, from leaked fuel at a Maryland dock (left) to dairy manure spread on an Amish farmer's fields in Pennsylvania (above). An 80-year-old pipe spews sewage into Baltimore's Stony Run (below), and proliferating parking lots (right) shed 40 times as much rain—laced with car drippings—as the forests they often replace. Toxic runoff is so rife in Washington, D.C.'s Anacostia River that nearly half of its brown bullhead catfish (below right) have liver cancer.

The bay today has become the ecological equivalent of a morbidly obese person, force-fed nitrogen and phosphorus.

(Continued from page 28)

said Wade H. "Wadey" Murphy, Jr., her captain and a fifth-generation waterman. "I loved drudgin' for oysters like . . . life," Wadey said. "But tourism's coming, oysters are going."

He showed me a photograph taken in 1948 near where a new gated resort community now stands. The late Bill Page, a waterman, was in his skiff, grappling oysters from the clear shallows with scissor-like tongs. A stranger onshore, A. Aubrey Bodine, had orchestrated the moment, motioning Page to move a few yards. "Ain't no oysters there," Page had replied. Humor me, Bodine had said, and he snapped a shot that has become a bay classic. Wadey said Page always told people it was a fine picture, but he invariably added: "Where he had me pose, there weren't no oysters."

Baywide, oysters were abundant in 1948, with harvests of several million bushels a year in Maryland. But within the past two decades the catch has plummeted, hit by disease, from around a million bushels to 26,500 last year.

No one's feeling any pain, however, at Harrison's Chesapeake House, down the harbor from Wadey. The sportfishing fleet's back from a charity tournament with a haul of striped bass. At

The bay scene is changing—and

the waterfront bar, the country music's cranking and the beer's flowing. Striped bass—also called rockfish or just plain stripers—are great fighters and good eating, a firm white meat that needs no help from any sauce. Now managed under strict quotas, the stock has come roaring back.

The crowd of tourists at the weigh-in oohed and aahed as a handsome 33-pounder made the scales creak. The overall catch was sparse, but contestants said they were happy just for the chance to snag a big one. Suddenly people began pointing their cameras toward the water. There, perfectly accentuating a Chesapeake scene of cotton-puff clouds floating in a clean blue sky across sparkling waters, were Wadey and *Rebecca T. Ruark* on their final cruise of the day.

And I wanted to holler to the happy skipjack-watchers and easily satisfied fishermen: *But there aren't any oysters out there anymore!*

Yet as the stripers indicate, Chesapeake Bay is far from dead. During my kayak journeys I could still feed from it—belly and soul—as I paddled through remote marshes, passing close to ospreys, herons, pelicans, and bald eagles on their nests. The bay scene is changing, though, and there's an air of finality to it now. Crisfield, Maryland, which once proclaimed itself Seafood Capital of the World, is knocking down the old oyster houses for condos. Commercial clam growers in Cape Charles, Virginia, are struggling against pollution from upscale clusters of several thousand homes. And Solomons, Maryland, a thriving fishing village not long ago, is trying hard to become a sailing center like Annapolis, the capital of Maryland.

Another sign of the times: "Chesapeake style" crab dishes are still on local menus, but many are full of imported Asian crabmeat. Plump fried oysters, lightly breaded and crisped a golden brown, are widely available too—but they're trucked in from Louisiana and Texas for the most part. That a local seafood culture can prosper without being supplied locally worries me. It implies less urgency to make the bay healthy.

From Crisfield it's a three-hour kayak crossing to Tangier Island, a windswept marsh encompassing three slender ridges of barely dry land. It lies at the bay's center, just south of the Maryland-Virginia line. The persistence here, after more than two centuries, of what can still be described as a thriving waterman culture defies logic. But then no place I know works—or prays—harder than Tangier. In 1989 townspeople quadrupled property taxes to help finance a seawall to stave off erosion. In 1998, swayed by an environmentalist who shared their evangelical beliefs, around half the island's watermen stood in church to make a "covenant with God." They pledged to observe fishing and pollution rules, "to protect our heritage and ensure a future for the next generation."

A new school serving the island's 99 kids boasts one of the lowest dropout rates in Virginia. On the wall of his office, Tangier native and principal Denny Crockett has one clock showing 10 a.m., another establishing that it's two hours to high tide. "Tides sometimes cover the whole island," Denny said, "so I need to know when to let kids out early so they won't be wadin'."

When I told him I was going crabbing with one of his graduates, Denny said: "James

there's an air of finality to it now.

Growing up where no one ever locked a door, former watermen and women from Smith Island, Maryland, now lay down the law at a mainland prison. "If it weren't for God and Tylenol, I'd never have got through the academy," says Janice Marshall (above, at front), aka Grandma Dynamite, who used to pick crabs for a living. Oysters, once the bay's other money crop, have been decimated by disease, closing shucking houses (right) and a way of life

Eskridge, I'll bet. He's got the get-up-and-go, and he hates anyone to beat him. If James doesn't make it, we might as well all pack up and leave."

It was 3:15 a.m. when James's dad, James Sr., known about town as Ooker, met me at the Double Six coffee shop. "James says, d'ye get seasick?" Ooker asked. "'Cause he's not comin' in till he's done, and it's gonna be blowin'."

Ooker delivered me aboard James's 37-foot workboat, *Rebecca Jean*. James, 26, who's been crabbing since he was old enough to walk, briefly acknowledged me as he arranged baskets, bait, and crab pots in the glare of deck lights. Soon we were roaring out the channel with the rest of the Tangier fleet, churning the water to froth, spotlights stabbing the night sky. The east was barely gray when he located his first line of pots, a series of mesh-wire cubes tethered to a yellow-and-red cork marker on the surface.

"Guess you want me to act normal, like I'm by myself?" James asked. With that, he flicked a switch to two big all-weather radio speakers: "HalleLUUUyah! HalleLUUUyah! JOY MAKES ME SING! You're listening to praise music, 102.5." Backing in full reverse and simultaneously wielding a long pole, James hooked his first cork and in the same instant fed its line into a hydraulic pulley that shrieked as it rocketed each pot, with a dozen or so trapped crabs, to the surface. Hoist the pot aboard, dump the crabs, bait with another fish, full throttle ahead another 30 yards or so to the next pot.

Hook, pull, hoist, dump, bait. Pumped by the beat, slamming gears then sorting crabs by sex and by size, James ruled the deck with the power and precision of a prizefighter. He would fish 300 pots before the day was over—he was fishing about four pots to the song.

Although he opposes their recommendations, James is well aware of scientists' concerns about the steep downward trend in the bay's blue crab population since 1990. Spawning females are at historic low levels. To reverse the decline, Maryland and Virginia have restricted the hours crabbers can work. Maryland has also increased size limits, and Virginia has put an additional 270 square miles of bay off-limits to summertime crabbers. Watermen say the problem isn't just them. It's also pollution, which is killing the crab's underwater grass habitat. But so far it's been easier to regulate watermen than pollution.

Has James considered leaving home for weeks to work on tugboats like nearly 20 other young Tangiermen? "NO!" he replied, adding, "well, never say never, but it would have to get real bad before I'd give this up." He said he'd wanted this life since he was six, when his grandmother made him a miniature set of waterman oilskins.

James may be the exception, as I learned from Cindy Parks, the state's commercial fishing license agent on Tangier Island. Parks estimates that out of some 170 licensed watermen on Tangier, maybe 100 crab for the entire summer. And only a few of those are young men, Parks said. "We're losing our young people. We had seven babies last year, and that was a big crop."

All across the bay there may be no more than

The latest ecological report card gave

Middle schoolers from Rockville, Maryland, head out to hunt for arrowheads and other marsh treasures during a three-day field trip to Port Isobel, an education center on Tangier Sound run by the Chesapeake Bay Foundation, a nonprofit environmental group. Educators and local watermen teach kids how to catch crabs, dredge for oysters, and appreciate the bay's natural bounty. The take-home message: Everyone lives upstream.

2,500 watermen crabbing full-time now, down from an estimated 10,000 baywide a few decades ago. Tangier has held on better than many other waterman communities, but one has to wonder whether a generation from now, with or without their covenant, James Eskridge and others will still be out on the water hoisting crabs.

A couple of hundred miles north of Tangier Island, I parked my car beside the barn on Harold Wissler's neatly kept farm in Voganville, Pennsylvania. If he and Eskridge met, they'd probably get on well: Farmers and watermen share a natural sympathy born of their independent lifestyles and wariness of government intrusion.

But farming intrudes heavily on the ability of places like Tangier to make a living. For more than a decade, agricultural researchers around the bay have been documenting how farming—even with the best controls—still "leaks" far too much pollution. The bay today has become the ecological equivalent of a morbidly obese person, force-fed nitrogen and phosphorus. Excessive amounts of these nutrients and sediments have depleted the water's oxygen and killed about two-thirds of underwater grass beds vital to crabs, fish, and waterfowl.

"You have to use the land so intensively now to make it on these small acres," said Wissler, 62, who raises corn, barley, soybeans, beef cattle, and a quarter million chickens a year, all on his modest 97-acre Lancaster County farm. Farmers here have doubled their use of manure in the past several decades, adding more crops and animals to increase their profits. Such productivity is why Lancaster County alone yields enough meat, milk, and eggs to feed more than half the people living in the bay's watershed. But this "fat of the land" translates directly to an over-fatted bay,

the bay a failing grade of 27 out of 100.

It was easier years ago to lose oneself in the

While some famous species have suffered, a few newcomers have benefited from the altered landscape. Snow geese—an uncommon sight on the Eastern Shore in the 1960s—now number more than 130,000 in the region. They feed on cornfields where forests once stood.

bay's more than 11,600 miles of coastline.

as excess fertilizers wash into the Susquehanna River, which provides about half of the Chesapeake's fresh water.

Agricultural pollution control is largely voluntary in Lancaster County and throughout the bay's watershed. "I'm regulating 240 farms out of more than 5,000 here—the rest don't come under any state or federal standards," said Kevin Seibert, nutrient program manager for the county's conservation district. "We've been working here with farmers for decades, and most of those willing to be educated *have* been educated."

According to Seibert, Harold Wissler is doing more than most Pennsylvania farmers to control runoff. He spreads only as much manure as he needs to grow his crops, shipping the excess to a broker for mushroom growers, who pays him seven dollars a ton. But farmers must do a lot more to reach the approximately 40 percent cuts in nutrient pollution needed to restore the bay. An experiment on farms in Maryland went well beyond anything Wissler does, eliminating manure and planting special crops in the fall to absorb excess fertilizer. Pollution was cut by 25 percent, while maintaining yields. State officials in Pennsylvania, Maryland, and Virginia now have plans to dramatically cut farm pollution, but they're still mostly just that—plans on paper—and may remain so until the states find the hundreds of millions of dollars needed to help farmers meet the new standards.

What more could Wissler do now to help the bay? Seibert ticked off a list of added measures like building more manure storage containers and planting the fall crops used in the Maryland experiment. When I suggested them to Wissler, he responded patiently. "Well, it would be very difficult. It would move up my retirement pretty fast." If so, he'd have no trouble selling his farm: Land-hungry developers are paying up to $20,000 an acre in Lancaster County.

No one said cleaning up the bay would be easy. Bernie Fowler knows that better than anyone. He's my inspiration for paddling some 55 miles in four days down Maryland's Patuxent River, from its upper reaches amid the Baltimore-Washington megalopolis, to where it broadens majestically between rural shores near its meeting with the Chesapeake. There, for the 17th year in a row, we're going to wade into the river, up to our shoulders, hoping to see our toes. It's been decades since the bay was clear enough to do that.

A former state senator and native of Broomes Island on the lower Patuxent, Fowler, now 81, has spent nearly half his life fighting to make it possible to see clear water again. He's prayed and politicked, begged and sued: Led by Fowler in 1977, three counties along the lower part of the river sued the state and federal government and won, leading to a commitment of hundreds of millions of dollars to reduce nitrogen and phosphorus from sewage-treatment plants.

For a time the Patuxent looked like a model for bay-wide restoration, but even its cleanup hasn't been enough. "A lot's been done, a whole lot," Fowler allowed. "But we still don't have a lot of underwater grasses, crabs, or oysters. We don't have as many fish. This river and this bay are still a disgrace."

In 2003, for the first time, University of Maryland scientists graded the Patuxent's water quality, fisheries habitat, and abundance of algae. They gave it a D plus.

"I tell my grown son about when 60 oyster boats were working out of Broomes Island, and 12 commercial fishing operations, and about catching six sugar barrels of crabs a day, and he can't believe it," said Fowler. "And that's my fear—we're coming to accept the river as it is."

"If we do right by water quality...

By now a good-size crowd had assembled to hear speeches before the testing of the waters. Once the bay is put on a healthy, reduced-nutrient diet, explained Walter Boynton, a top bay scientist who lives and works on the Patuxent, it will respond "in a year or two." Indeed, when a recent drought cut polluted runoff, water clarity and underwater grasses rebounded, and the bay's dead zone, where dissolved oxygen is too low to sustain life (less than one milligram per liter) shrank. "If we do right by water quality—cut nutrient pollution by about half—we won't pay for the sins of the past."

Anson Hines, a marine ecologist at the Smithsonian Environmental Research Center near Annapolis, had a similar message about the bay's crabs, which are incredibly fecund and mature

we won't pay for the sins of the past."

"It was wham, bam, left and right!" says angler David Waldsmith (above) of his morning fishing for American shad in the Susquehanna River below Conowingo Dam. Intensive stocking and improved fish passage on spawning streams have helped shad come back from near extinction. New technologies to reduce the impact of development, like storm-water thirsty median strips in Maryland (right), may also improve stream health.

and reproduce quickly. With a combination of conservation and restored environmental quality, Hines said, "it may be possible they could rebound fairly quickly."

Oysters are another matter. A debate is now raging over introducing an Asian species that reportedly grows fast and resists the native oyster's diseases. Even if officials decide that the benefits of bringing in an exotic oyster outweigh the risks, "we may be looking at decades before we have significant stocks of non-native oysters," said Ken Paynter, a University of Maryland biologist.

The moment had come for Fowler and me, and into the Patuxent we went. But a stiff wind had churned the water, and I made it to around knee-deep before my size 15 sneakers vanished, nearly a yard short of our shoulder-high goal.

Why isn't the Chesapeake in better shape?

Public support is like the estuary itself,

Two decades ago the hope was that by reducing excess nutrients by 40 percent, we would have returned the bay's water quality to 1950s levels by now. Yet efforts have focused mainly on sewage treatment, the easiest target politically and financially because laws were already in place. Unquestionably, dealing with sewage is important—Maryland just passed a law that will generate another billion dollars to further upgrade treatment—but sewage contributes only about 60 million of the estimated 275 million pounds of nitrogen entering the bay every year. The Environmental Protection Agency calculates that restoration will at minimum require cutting excess nitrogen by 110 million pounds a year.

A lack of both political will and enforcement has slowed progress in tackling the other big pollution sources—agriculture, cars, power plants, and urban storm water. We've been similarly lax in containing the sprawl consuming forests and wetlands—vegetation that absorbs millions of pounds of nutrients from polluted air and runoff—at the rate of more than 100 acres a day. And the demise of oysters, which once filtered and cleansed huge volumes of bay water as they fed on algae, has been an ecological disaster. "It's like someone removed 99 percent of the filter in your aquarium," said Bill Goldsborough, a fisheries scientist with the Chesapeake Bay Foundation.

In theory we're now assembling the pieces to make the puzzle of bay restoration work. Under the federal Clean Water Act, if the bay states aren't making real progress in reducing excess nutrients by 2010, federally mandated pollution controls could usurp the states' efforts. To avoid this, the states have produced detailed lists of actions to achieve 1950s-grade water quality. These include everything from less polluting types of agriculture to cleaner technologies for septic tanks and reduced use of lawn fertilizer. A panel of businesspeople, politicians, and environmental leaders is seeking some 15 billion dollars in federal and state restoration funding.

Cleaning up the bay by 2010 seems highly unlikely. A recent report co-authored by Donald Boesch, head of the University of Maryland's environmental research laboratories, suggests restoration will be possible by 2030—but only if

Anglers on Tangier Island enjoy the bay's simple—and fragile—pleasures. Virginia and Maryland officials met here last year to discuss how to restart a cleanup hamstrung by politics, protest, and inertia. "It's going from science to social science," says Scott Phillips, Chesapeake Bay coordinator for the U.S. Geological Survey. "You're going to have to change people's values to improve this ecosystem."

we pursue our goals aggressively.

Paddling down the Patuxent last summer, reflecting on the slow progress of voluntary cleanup, I began to think the best recourse now is to heed the advice Bernie Fowler got years ago from a mentor: "Sue the bastards." At least two environmental groups have recently taken legal action against polluters and enforcement agencies. But no amount of lawsuits can be expected to turn the water-quality clock back half a century if more than a million people are added to the region every decade. Controlling growth may be a national issue, but what better place to begin than in the bay's watershed, where the U.S. government resides?

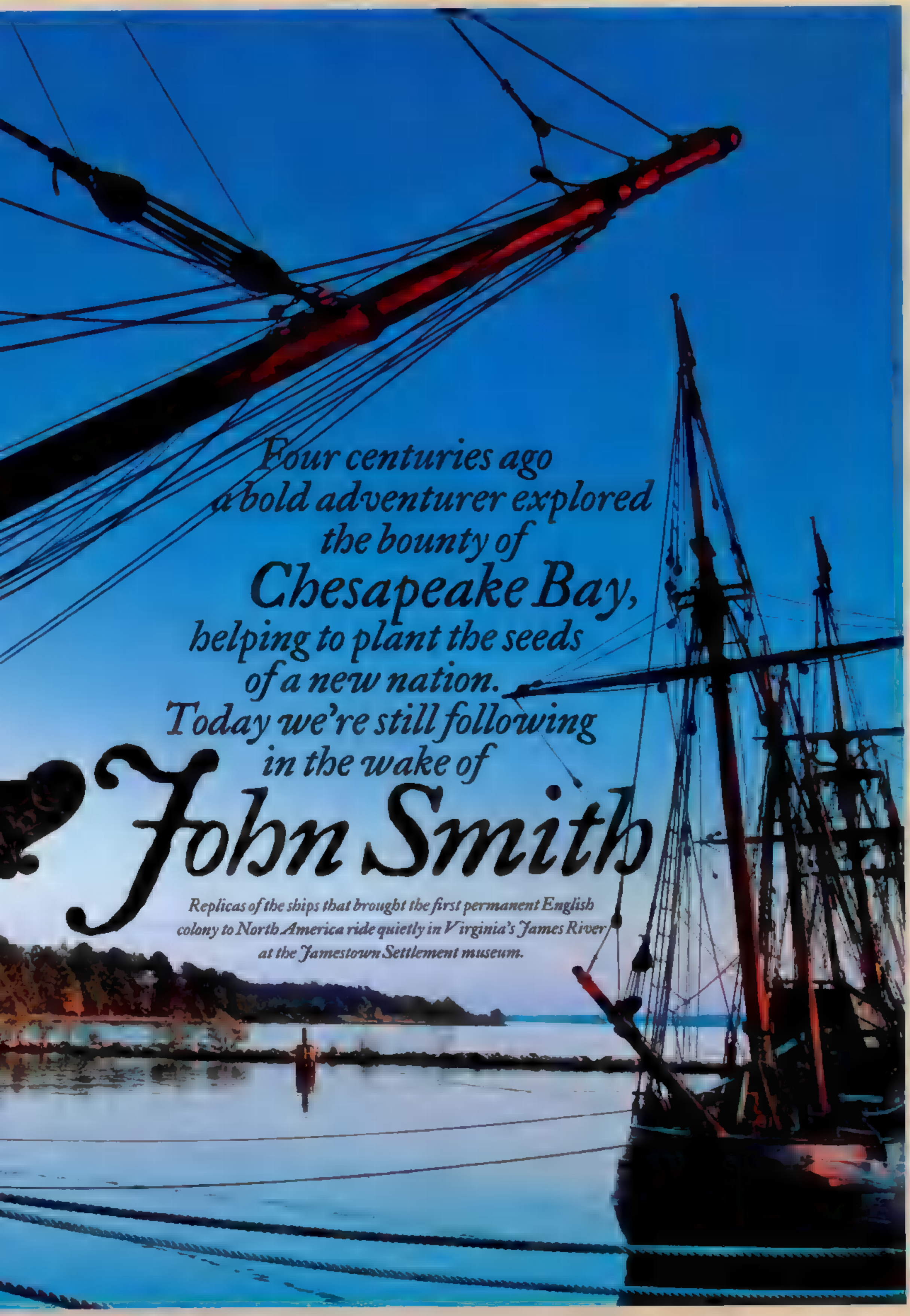
Do we have the will to restore the Chesapeake? Public support often seems like the estuary itself, impressively broad but deceptively shallow. Walter Boynton, the Patuxent scientist, recalls how when he arrived on the Chesapeake nearly 40 years ago, oysters were "an essential food, part of the culture—and now they're an hors d'oeuvre. I wonder if the bay has become like that for many people, from being essential to an hors d'oeuvre."

I only hope he's wrong. As Fran Flanigan, who organized the original bay restoration summit meeting in 1983, said in a recent speech, "Ultimately we're confronted with a question of values, which no amount of money can fix." □

WHAT WILL IT TAKE? Will billions of dollars be enough to clean up Chesapeake Bay? Share your thoughts in a forum, then listen to a Tangier Island waterman describe a vanishing way of life, or zoom in on a high-resolution map of the bay at **nationalgeographic.com/magazine/0506.**

impressively broad but deceptively shallow.

PETER ESSICK


Four centuries ago
a bold adventurer explored
the bounty of
Chesapeake Bay,
helping to plant the seeds
of a new nation.
Today we're still following
in the wake of
John Smith
Replicas of the ships that brought the first permanent English
colony to North America ride quietly in Virginia's James River
at the Jamestown Settlement museum.

"Neither better fish, more plenty, nor more variety . . . had any of us ever seen."
—John Smith

He was the kind of man historians either love or hate. A self-promoting chronicler of his own daring exploits, he has been celebrated as a hero and attacked as a liar. He arrived in the New World under arrest for treason and left two years later badly injured in an explosion. Yet if it were not for Capt. John Smith, says scholar Edward Wright Haile, "We might all be speaking French or Dutch."

Few explorers have left as controversial a wake as the young soldier of fortune who landed on a marshy peninsula in the James River in May 1607 with about a hundred gold-hungry Englishmen. By most accounts they were ill-prepared for this strange new land where they were surrounded by powerful Indian tribes that at times greeted them warmly, at times tried to fill them full of arrows. While many of the upper-class gentlemen rarely left the safety of the settlement, Smith was in his element catching massive sturgeon in nearby rivers or trading with the tribes for the corn, meat, and furs that sustained settlers the first lean winter. He learned enough of their language to write an early guide to Algonquian words. More than once he returned to find his colleagues dispirited, even preparing to flee back to England. He dissuaded them with food supplies, loaded muskets, or his impeccable charm. On a trip to find the source of the Chickahominy River, Smith was captured, frog-marched before various tribes, and brought before Powhatan, the chief of the federation that dominated the bay's shores. Smith later wrote that his head was thrust upon a stone as club-wielding warriors stood ready to bash in his brains. Only when Powhatan's young daughter Pocahontas laid her own head upon Smith's and pleaded for his life was he spared. Or so he said.

Helmet in hand, Jay Templin [above] describes the life of a colonist at Jamestown Settlement's re-created fort. Colonial history is still alive at nearby Berkeley Plantation for dancer Glenn Canaday [right] of the Chickahominy tribe, with which Smith traded for vital corn.

Whether or not it happened, no one will ever know. What is indisputable is that Smith was the first Englishman to explore and accurately chart the great estuary he called a "faire bay." In two expeditions, with a dozen or so men in a small open boat, he traveled nearly 2,500 miles, venturing as far as he could up the major tributaries in search of gold, silver, or that elusive route to Asia. Instead he discovered natural riches unlike any that modern inhabitants of the region can likely conceive: Endless forests full of bears, wolves, and deer. Massive oyster reefs, with shells up to a foot long. Schools of rockfish, bluefish, and menhaden so thick that Smith once tried to catch them in a frying pan. And "more plenty of swans, cranes, geese, ducks and mallards, and divers sorts of fowls none would desire." Smith soon grasped that this wasn't a place of quick riches, but of hard toil to reap nature's bounty —a task as daunting as efforts today to restore that bounty to the bay. ☐

—Joel K. Bourne, Jr.
NATIONAL GEOGRAPHIC SENIOR WRITER

PETER ESSICK (BOTH)

John Smith's expeditions

Though not a naval officer, Smith proved an able master of his small boat and a dozen or so men as he explored Chesapeake Bay and its tributaries. With the 400th anniversary of Jamestown nearing, some groups, along with bay area politicians, are urging Congress to recognize his routes as a national historic trail, so modern boaters can follow in his wake.

June–September 1608
In two expeditions Smith travels nearly 2,500 miles, often leaving brass crosses to stake England's claim.

December 1607
Smith is captured by Indians and brought to Powhatan, whose daughter Pocahontas reputedly saves him.

May 1607
At a peninsula on the James River, about 100 colonists land and begin building a triangular wooden fort.

Jamestown
Origin of voyages

Smith captured near here

Smith released

Barge disembarks from ship *Phoenix*

PENNSYLVANIA
SUSQUEHANNOCK
NEW JERSEY
VIRGINIA
MARYLAND
DELAWARE
ATLANTIC OCEAN
Chesapeake Bay
POWHATAN
Elkton
Havre de Grace
Baltimore
Annapolis
Washington, D.C.
Arlington
Alexandria
Nacotchtanck
ANACOSTAN
MATTAPANIENT
Moyaons
PISCATAWAY
PATUXENT
MATTAWOMAN
NANJEMOY
Patawomeck
Cedarmocomoco
MATCHOTIC
RAPPAHANNOCK
Toppahanock
Moraughtacund
YOUGHTANUND
Orapaks
Richmond
Powhatan
PAMUNKEY
Werowocomoco
CHICKAHOMINY
Berkeley Plantation
Hampton
Kecoughtan
Norfolk
CHESAPEAKE
Portsmouth
Cape Henry
Cape Charles
ACCOMAC
Easton
Possible route
Cambridge
CHOPTANK
NANTICOKE
Salisbury
Dover
POCOMOKE
MD
VA
0 mi 20
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SOURCES: EDWARD WRIGHT HAILE, EDITOR, *JAMESTOWN NARRATIVES: EYEWITNESS ACCOUNTS OF THE VIRGINIA COLONY*; WAYNE E. CLARK, MARYLAND HISTORICAL TRUST; KENT MOUNTFORD, COVE CORPORATION; CHESAPEAKE BAY PROGRAM; APVA PRESERVATION VIRGINIA (PORTRAIT)
NATIONAL GEOGRAPHIC MAPS

Spotted hyenas are one of Africa's most successful predators as well as surprisingly tender social animals. They don't deserve the

bad rap

By Chris Carroll
NATIONAL GEOGRAPHIC WRITER

Photographs by
Anup and Manoj Shah

Frenzy erupts at a kill site in Kenya's Masai Mara National Reserve as a female hyena chases vultures from a wildebeest carcass.

Bloodstained from feeding, *an adult female is greeted on her return to the den by two cubs that may or may not be her own. Spotted hyena clans are matriarchal, with females dominating groups of 80 or more animals. Clans often splinter into smaller cells, reassembling days or weeks later. To help ease the re-integration process, hyenas of all ages, ranks, and sexes engage in ceremonial one-on-one greetings. Hierarchical in all things, hyena etiquette usually requires the subordinate animal to initiate the greeting.*

Across an acacia-dotted plain in the Serengeti (above), nursing mother hyenas may lope 25 or more miles each way to hunt migrating herds of wildebeests and other grass-eaters. Among nature's most devoted mothers, they may make two such round-trips ■ week to maintain their milk supply.

Mile after mile the chase goes on. The gazelle tires, but not the spotted hyenas in pursuit. With a final surge of speed, the predators spring upon the flagging prey, drag it down, and disembowel it. Then a roar echoes across the East African savanna. The hyenas flee their feeding as a male lion takes over the kill. The thwarted hunters skulk nearby with empty bellies.

Hyenas have an undeserved reputation as thieves and scavengers that subsist on the leavings of the larger predator. "But it is far more frequent that the lion will steal a kill from the hyenas," says Kay Holekamp of Michigan State University. Biologists have known this for decades, she laments, yet hyenas are still viewed as "slobbering, mangy, stupid poachers" (not to mention goose-stepping fascists) in *The Lion King*, the movie that for many has defined the species.

Why do people grimace at the sight of them? With their patchy fur and odd proportions, maybe they flout our shallow standards for beauty in animals. "Our obsession with looks doesn't take into

account how well their bodies and brains are adapted to an ecosystem," says Anup Shah, who, with his brother, Manoj, photographed hyenas in Kenya, their homeland, and Tanzania. Among Africans, hyenas arouse humor and horror—the former because the genitals of the females inexplicably mimic those of males, giving rise to the myth that hyenas are hermaphrodites, and the latter because of a link with death. The Masai leave corpses in the bush for hyenas to dispose of. Indeed, hyenas eat almost anything, which makes them valuable. "They are very important to the health of the ecosystem," says Marion East of the Institute for Zoo and Wildlife Research in Berlin. "As scavengers, they clean up a huge amount of dead matter. As hunters, they probably help maintain the genetic health of the great herds."

HYENA CHEW TOYS Photographer Anup Shah's car tires did double duty. Find out more in his field notes, then view an online gallery of hyena images with photo tips and decorate your desktop with your own piece of the savanna at **nationalgeographic.com/magazine/0506**.

Cheetahs are usually too smart *to tangle with hyenas. But someone forgot to tell these cubs, and a rare showdown ensues on the savanna. Soon after bringing down a gazelle, a mother cheetah and her three nearly grown cubs get an unwelcome dinner guest—a lone female hyena. The cats know hyenas will steal any food they can, so they often time their hunts to coincide with hyenas' midday naps, from about 10 a.m. to 4 p.m. Sometimes the strategy fails. With the wisdom of age, the mother cat immediately gives way to the more aggressive hyena. Her brash youngsters, however, mount a challenge. One cub (above) makes a frontal charge before flitting away. The second (top right) buzzes the slower hyena. "They must have been really hungry," says Michigan State's Kay Holekamp. "I've never seen ■ cheetah go after a hyena. It's a dangerous thing to do." Though the confrontation may have been unusual, the outcome was not. The hyena eats its fill (right) in peace, while a young cheetah can only glare and hope for some leftovers.*

Returning home with fast food—*a chunk of speedy Thomson's gazelle—this young hyena has no intention of sharing. It could lose its lunch entirely, however, if a dominant hyena challenges it. That's why animals that rank low in a clan's hierarchy learn to eat fast and eat alone. This gazelle head isn't a prime cut, but the spotted hyena is adapted perhaps better than any other predator to making do with rougher fare. The great jaws and specialized teeth help slice through thick skin and stubborn tendons with ease. Hyenas will even crunch up bones, digesting the organic content and excreting calcium.*

A growl and bared fangs *signal that this voracious predator is fed up with the vultures vying for a wildebeest carcass it wants to devour single-handedly—an impossibility even for the hungriest hyena. Unsure of when they will next feed, hyenas will gorge themselves whenever they can. Although they often snap at vultures in the process, they rarely harm the rival scavengers. The relationship between the species is mutually beneficial: The birds often eat at hyena kills, and the sight of vultures alerts the hyenas to nearby dead meat. This hyena, disturbed by the swarm of scavengers, finally tore off a hunk of wildebeest meat and went looking for a more peaceful spot. After a big meal—big meaning not a few steaks, but 30 to 40 pounds of meat, nearly a third of their weight and far more, proportionally, than a lion would eat—digestion raises hyena body temperature. On such occasions, few things are more pleasant than a cool, postprandial mud bath (left). But even in the mud, the hierarchy rules. A lower ranking animal lounging in the same spot quickly made way for this dominant female.*

Snarling in the face of certain death, *a hyena cornered by lions in a Masai Mara bog has nowhere to run. Male lions seem to relish harassing and killing their smaller competitors. After delivering the hyena a fatal bite and toying with its carcass, this male and another lion began to play. "They had all the signs of excitement—eyes shining, and they were rolling in the grass nuzzling each other," says photographer Anup Shah. "It was a successful assassination."*

Shoulder to shoulder, *a clan faces down a young male lion off camera that has come into the hyenas' territory in Masai Mara. Tails up, ears back, and emitting an eerie call of aggression known as a "low," they edge closer, but the lion stands its ground. Had it been a full-grown male, such a show of force—the same tactic hyenas use when confronting rival clans at the edges of their territory—would have been too dangerous even to attempt. Safe near a den in Tanzania's Serengeti, two members of a clan (right) appear to be engaged in a painful fight, but they're just playing a friendly game, Anup Shah says. "It appeared one was saying, 'I trust you. You can do whatever you want with those teeth. I know you won't harm me.'"* □

In the shadow of Attila

Romania's Csángós cling to fading customs and beliefs—folkways of the nomadic Asians they claim as ancestors.

by **Frank Viviano**

photographs by **Tomasz Tomaszewski**

Suspicion darkens 80-year-old Juliánna Tímár's face as a stranger approaches her home in Romania's Carpathian Mountains. Her wariness belies the warmth found among the 250,000 Csángós, who struggle to sustain the traditions of their pre-European past, when borders, and national identity, were fluid.

Minutes from the highway, centuries from modern Europe, a medieval landscape lingers in Fundu Răcăciuni. Romania hopes to join the European Union in 2007. But for Csángó farmers like András Dudás (right), the fruits of continental cooperation seem a world away.

Bibi Koszan was a sorceress, an accomplished 23-year-old witch and fortune-teller, as well as a fervent Roman Catholic. At our meeting in the village of Arini, at the end of a rutted mule track in the eastern Romanian region of Moldavia, she rocked to and fro under a framed print of the "Last Supper," willing herself into a trance as she spread 41 kernels of dried corn on a table and arranged them in rows.

Her four-month-old son stared intently at us from a straw cradle perched on a chest, babbling his encouragement. "Here is the stranger," Bibi chanted, waving a hand over the first row of corn, then moving on to the others. "Here is your heart, and here is your house."

She had stolen her secrets from an older witch, pretending to be an ordinary client while she memorized the incantations and rituals of white magic. "Theft is the only way, our forefathers' way, to acquire these powers," she told me.

Then she went on with her reckoning of my prospects, divined in 41 kernels of corn. The details, which I'll keep to myself, were as enigmatic as Bibi's people—an ancient, restless tribe known as the Csángós, which roughly translates as "wanderers."

By their own account, they are the lineal heirs of Attila the Hun—a link to the nomadic ancestry of most residents of Europe, a window on the Asian origins of what we now think of as Western civilization.

Arini lies less than 300 miles from the European Union, from the world of genetic engineering, space exploration, and Internet surfing, a world that Romania is scheduled to join in just two years. But in their traditions, their absorption in magic, sorcery, and shamanistic charms—their consciousness—the Moldavian Csángós inhabit a timeless universe thousands of miles to the east, where the fixed assumptions of the 21st century have little force.

Bibi vaguely regards herself as Hungarian, and her chants are spiced with words from the vocabulary of ninth-century Magyar warriors who followed Árpád, Hungary's founder, across the Carpathian Mountains into the heart of Europe. Yet neither she nor her ancestors have ever lived in a country called Hungary, and the Romanian authorities deny that they are Hungarian at all. Even nationality, in its modern guise, is an ambiguous concept for the Csángós—and far less "real" than the hallucinatory arts Bibi practices. But as I roamed across their archaic realm, I came to

Barely holding on to his roots, János Attila Jánó rides on lands his ancestors settled some eight centuries ago.

Whether those forebears were Huns (as his name suggests), Hungarians, or Romanians remains unclear. Both Hungary and Romania claim the Csángós as their own—a source of tension between the two nations.

believe that its very ambiguities held a deep contemporary resonance.

Every nation has a defining moment—a moment that proclaims, in the collective imagination, "This is who we are," and its almost universal corollary, "This land is ours." Nationhood is born in such assertions, a specific identity permanently rooted in a specific place. But the Csángós were different. The sense of permanence, of rooted certainty, seemed absent from their lives.

They were a living reminder that the world is always an unfinished project, subject to endless change, and that the assertions "This is who we are" and "This is our land"—the cornerstones of the modern nation-state—are ephemeral.

Three separate and distinct communities in Romania, dating back more than eight centuries, bear the name Csángó (pronounced CHAHN-go). The smallest group, referred to as the Seven Villagers, lives in a string of villages near the city of Braşov in the center of the country; converted to Protestantism during the Reformation, they are the only

She had stolen her secrets from an older witch, pretending to be an ordinary client while she memorized the incantations of white magic.

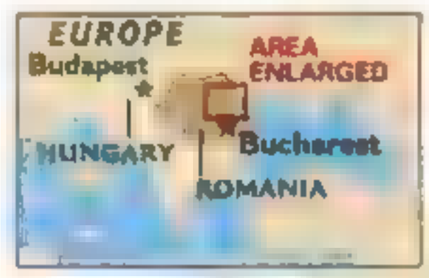
non-Catholic Csángós. A second small community is concentrated in the remote Ghimeş Valley of the high Carpathians. Together, the Seven-Village and Ghimeş Csángós have an estimated population of less than 25,000. By far the largest of the three communities—up to a quarter of a million people, depending on who does the counting—inhabits the flatlands of rural Moldavia, although its precise numbers and ancestry are matters of controversy.

"What *is* certain," said a Budapest ethnographer, when I described the séance at Arini, "is that the archaic universe of the Moldavian Csángós comes from elsewhere."

That elsewhere lies unmistakably to the east. Against the odds of time and history, the Csángós—after a thousand years in Europe—are still so recognizably Eastern, in custom and mentality, that among them I often felt I had returned to my earlier reporting haunts in Central and East Asia.

Nowhere was that sensation more pronounced than in the whitewashed cottage of Rózsa Istók near the town of Cleja, 20 miles west of Arini along a small tributary of the Siret River. "These are the things that matter to

Beneath a homemade calvary in Şomuşca the Benke family lunches during the harvest. For predominantly Catholic Csángós, religion unites their villages and often means more than nationality. Folk music—and folk medicine—also infuse Csángó life. In Valea Rece a student flinches as his teacher offers to treat his blister with a dab of plum brandy.



● Settlement with Csángó population

0 mi 40
0 km 40
NG MAPS

us," the 70-year-old Rózsa said of the heirlooms that filled her sitting room. "These are the things that have value."

They were the same measures of wealth I'd seen in the pelt-covered *gers* and yurts of Mongolia, western China, and Turkmenistan: ornate silk vests, hand-loomed pillowcases, and colorful bolts of wool, all neatly folded and stacked as though waiting for sudden transfer to the back of a horse. Csángó valuables were the portable treasures of Asian nomads.

Each item had a story, a separate fabric of meaning spun from ancient designs Rózsa and her neighbors embroidered on their clothing, designs with the same magic-infused Asian roots that underpinned Bibi Koszan's profession and the daily routines of Arini and Cleja.

The Csángó language was a de facto guidebook to the nomadic passage west. In addition to Magyar, it featured words adopted from a dizzying array of cultures encountered along the medieval invasion routes into Europe. To manage the simplest exchanges in Csángó Moldavia, much less arcane conversations with witches, I relied on a shifting cast of interpreters and sub-interpreters, with sentences passed along a chain of local guides who provided translations of Romanian, Turkic, and Persian phrases, and fragments of long-vanished tongues such as Avar and Petcheneg.

I had listened, with my interpreters' help, as a friend of Bibi's, in an earthen-walled hut that was the perfect likeness of its counterparts in western China, moaned an eerie sing-song incantation to help her feverish six-year-old daughter "spit out" a head cold. "She's under the influence of an evil eye," the mother said. "There is someone in our village who wants to bring us bad fortune."

Ethnographers say such beliefs are directly related to the practices of certain Kazakh tribes in northern Mongolia. Bibi Koszan's corn kernels and Rózsa Istók's textiles are links in an immense chain of Asian nomadic rituals that have been preserved by the Csángós, often under a frail Christian veneer.

"The first evening after a child is born to a traditional Moldavian Csángó family," I was told, "the parents pick it up and present it to the moon goddess, Baba Maria, who may be of Persian origin. This is also their name for the Virgin Mary."

Baba Maria. It was the name Rózsa had used, as we warmed our hands over a clay stove fueled by dried corn husks, to describe the image of Mary that her neighbors had seen floating in the sky at dawn during a religious pilgrimage.

As Rózsa told her tales, her voice slipped into a mesmerizing rhythmic cadence, tracing a long genealogical line back to the day when one of her ancestors swung down from his horse here, deciding to take his rest. I found myself thinking that Homer must have sounded something like this on a distant Attic night, chanting genealogies from the Trojan War or describing the wanderings of Odysseus between Asia and Europe. The village of Cleja had more affinity with ancient Greece than it did with the 21st century.

A stag, rendered as a nearly abstract stick figure with horns, is one of the most common designs that appear in the textiles of Cleja. The Csángó villagers confidently declare that their presence in Moldavia is explained by that stag.

Three princes, they will tell you, came across the stag while hunting on the steppe. Their names were Csaba, Magyar, and Hun, and in their chase they followed the prey all the way to the Carpathians, discovering Europe.

Blood streaks a blanket of snow in Valea Rece, where a freshly slaughtered pig will help the Almási family weather winter. The Council of Europe has urged Romanian politicians to hasten economic development in poor Csángó communities, but little aid reaches them. Most live on what they barter, collect, or grow for themselves.

It required little imagination to hear, in this tale, a folk memory of actual invasions from the east. Hun, in some versions of the stag legend, was the son of the great chieftain Attila, who stormed over the Carpathians in the early fifth century, conquering much of the European continent before his death in 453. Magyar's descendants are said to include Árpád, who led his federation of Asian tribes west in 896, pushing beyond Moldavia to the plains where the Kingdom of Hungary was established in 1000. As for Csaba, in the stag tale he is sent back to Asia for reinforcements when he and his brothers encounter stiff resistance from rival tribes.

Csaba, say the Csángós, is their own ancestor, the last of Attila's sons to battle his way over the Carpathians. In 2005 their universe still resounds with echoes of the great invasions that shook Europe 1,500 years ago, after the Roman Empire tumbled into decline.

The legacy of those invasions, declared in rival claims for the same land, was written all over the historical atlas I carried across Romania. The northwestern city of Cluj-Napoca was Kolozsvar to its former Hungarian rulers and Klausenburg to the Saxon Germans who arrived there in the first decades of the 13th century. Tîrgu Mureş, where I headed east for Csángó Moldavia, was Marosvasarhely for Hungarians and Neumarkt in Saxon.

You need look no further than the Saxons to appreciate how suddenly everything can change. They once prevailed in the area of Braşov; soon, no trace of them will remain beyond half-forgotten place-names and soaring Gothic churches. In 1940 there were 800,000 Transylvanian Saxons and other Germans in Romania. Today, following a wave of emigration that crested under the late Nicolae Ceauşescu's dictatorship in the 1980s, there are fewer than 60,000. The sentence "This is who we are" was proclaimed here in German for almost eight centuries before subsiding into a faint murmur in a single generation.

As for the Csángós, there is no consensus on who *they* are. Indeed, their very name is the subject of fierce debate.

The most common interpretation, favored by the authoritative

Csángó colors of red and green distinguish a folk dancer's head scarf from the blue and yellow of a Romanian dress. The different palette pays. Hungarian tourists now visit Csángó villages, offering cash for displays of traditional dancing and music.

Hungarian Etymological Dictionary, is that the name is derived from the verb *csangal,* to wander or live apart. A rival theory argues for the verb *csangat,* to sound alarm bells. The connotation in both cases is that the first Csángós were the rear guard of early Magyar settlement in Europe, posted on the eastern frontiers to signal the approach of subsequent invaders.

Romanian scholars, however, contend that the Csángós, especially those in Moldavia, are descendants of the Vlachs, ethnic Romanians who were taught an archaic dialect of Hungarian by Catholic missionaries in the Middle Ages.

For Bucharest, to claim that the Csángós are Vlachs is also to claim that the lands they inhabit are incontrovertibly Romanian. But for Budapest, the Hungarian dialect, customs, and predominantly Catholic faith of the Csángós is proof that these same lands are at least culturally linked to greater Hungary.

Virtually all of the 240,000 Catholics in Moldavia, an otherwise Orthodox region of 4.7 million, are either Csángós or descendants of

The gentle arc of a bouquet at a Western-style wedding in Fundu Răcăciuni hints at the rise of mainstream culture. Assimilation has been the safest course for many Csángós, who were oppressed under communist regimes and still suffer discrimination today. Says Reka Pavai, ■ ***young teacher: "It's more convenient to seem Romanian."***

Csángós, says Andrew Ludanyi, a Hungarian-American political scientist, who dismisses the Vlach theory as groundless. Romanian officials counter that three-fourths of Moldavian Catholics speak little or no Hungarian, and that fewer than 2,000 formally declared themselves Csángós in the country's 2002 census.

As I traveled through their land, I heard tale after tale of systematic repression of Csángó culture by government and church authorities in Moldavia. Many Csángós were afraid to openly embrace their identity. A 2001 report by the Council of Europe notes that school classes in Moldavia are conducted in Ukrainian as well as Romanian, and that Polish, Romany (Gypsy), and Russian are taught as legitimate mother tongues. But until the recent expansion of laws in Romania guaranteeing minority cultural rights, which authorized classes in Hungarian in Moldavia, that language had been entirely absent from the region's public school curriculum.

The controversy is built on the same argument that set Serbs against Croats and Muslims in the ruins of Yugoslavia and attracted millions of European votes in recent years to xenophobic political parties. It is the argument of ethnic-blood right, the violent underside of modern nationalism.

When you leave the Moldavian floodplain headed west into the high Carpathians, the Hungarian language takes firmer hold, and the journey is measured by yet another stripping away of centuries. At the hamlet of Cîmpeni, I parked for a few hours at a country market that might have been plucked from a painting by Bruegel. On its fringes, Gypsy traders led draft horses dragging boulders in circles, to demonstrate the animals' enormous strength. Peasants wrapped in thick wool cloaks against the damp morning air haggled over barrels of seed or sat in rough wooden shelters warding off the chill with tumblers of *palinka,* explosive plum brandy. There was one other automobile at the market, a forlorn Romanian Dacia of uncertain model and age that had been reduced to ■ mule cart—the engine removed, the body stripped to its chassis, a harness attached to the front bumper, the trunk open and squirming with piglets for sale or barter.

Beyond the town of Palanca, where Hungary's eastern border was drawn until the Carpathians were ceded to Romania after World War I, the rudimentary money economy of Cîmpeni all but disappeared. When a stranger wanders into the Ghimeş Valley, a Csángó inevitably approaches to offer a place to sleep. It's only with a guest's insistent pleading, at the end of the stay, that a Ghimeş host will grudgingly accept the equivalent of a dollar or two a night for room and board.

Ilonka Tankos wouldn't even accept that much for providing lodging and meals, which was embarrassing enough. Her concern for me, after I'd wrenched ■ muscle fording a mountain torrent swollen from spring rains, only made things worse for my pride. By the time we arrived at Ilonka's *kaliba,* her shack under the tall brow of Tarcau Mare, I was barely

This is the raw, hardy society of the Carpathians as it must have been when Attila and Árpád rode through, leading their warriors forward.

able to limp. "You poor man," she said. "This is the kind of road that we white people are used to, but it's not for someone like you."

"White people," in the Ghimeş dialect, refers to Csángó women. "It's something like saying 'the fairer sex' in English," my interpreter explained. In Ilonka's case it bore no discernible implication of weakness.

She had reached the shack an hour before us—carrying five pounds of cured sausage, a two-gallon jug of wine, and a bottle of palinka—on a shortcut that zigzagged so steeply up the mountainside that it made me queasy just looking at it.

Ilonka was a widow, just shy of 70 years old.

This is the raw, hardy society of the Carpathians as it must have been when Attila and Árpád rode through, leading their warriors forward into the plains. Their women, the "white people" who were Ilonka's predecessors, remained behind in mountain camps with the tribal flocks, presiding over what was essentially a matriarchy while the men were off on raids of conquest that could last for years.

In effect, the Ghimeş is still a matriarchy; thousands of Csángó men

From improvised cradle to grave, Csángós rely on large family networks for care and support. In Vladnic a girl stands by her baby brother; in Pustiana elderly sisters enshroud their mother for a traditional Csángó funeral. The social web has held fast for generations but now is fraying. Poverty has driven many young adults abroad in search of jobs. This migration splits up families, leaving children and the elderly behind.

have gone abroad as guest workers. The few able-bodied males who have returned—like Ilonka's son Imre, who said he was temporarily between jobs in Hungary and Austria—scrape by as subsistence farmers or herdsmen. The factories that once employed many of them in the grimy mill towns of Moldavia and Transylvania, an hour or two's bus ride away, were shut down a decade ago.

In many respects age-old Magyar customs have been maintained even more faithfully here than in the Moldavian lowlands, perhaps because shepherds and cowherds are themselves nomads, following the seasons from mountainside kalibas to riverbank meadows.

One of those customs is recalled in rough log cabins with two adjacent front doors. The first opens into a common room equipped with a stone hearth for cooking, a table, a few simple beds, and a chest stacked with the familiar hand-loomed textiles and pillowcases. The second door leads to a separate, private area where a teenage Csángó daughter traditionally slept—and where she was permitted to receive her lovers in the old days.

The custom isn't practiced anymore, though some recently built cabins still have two suggestive front doors, but other expressions of Csángó frontier culture are as vital as ever. Traditional music is everywhere in the valley, whistling from the *tilinká*, a three-foot-long flute without fingering holes, also known as a shepherd's pipe, and plucked out on the *koboz*, a rudimentary lute. The tilinká and koboz sing—in both laments and dance tunes—to the rhythmic cadence of a baton thumping the taut string of a *gardon*, a percussion instrument that, oddly,

resembles a large cello. More often than not, it is music not on the Western octave but on a pentatonic scale, the five-note music of Asia, "which can be traced all the way to China," says folklorist Zoltán Kallós.

Kallós, a renowned expert on folk music, has cataloged more than 10,000 Hungarian songs, a large number of them on forays into Csángó country. Many, he says, are stylistically identical to their counterparts in Mongolia and among the Uygurs of China's Xinjiang Province.

What also characterizes Csángó music, especially in the high Carpathians, are ballads that celebrate the nomadic life, sagas of restlessness and archaic liberty.

"I have neither a country nor a home," András Ambrus sang, as he staggered past me one evening in the Ghimeş village of Lunca de Jos. Ambrus, who was enthusiastically drunk, stopped to introduce himself and offer what proved to be an empty bottle of palinka. Then he wandered on, resuming his song: "A thorny rosebush is my only abode. And even there my stay should not be too long."

He might have been singing about where the Csángós—and Europe—had been long ago. And where they are today.

The young man at the door of my house in Tuscany, come to repair a leak in the plumbing, had blond hair and unusual almond-shaped blue eyes. He spoke with a strange, lilting accent. That was five years ago, before I'd ever heard of the Ghimeş Valley or Arini.

"What part of Italy are you from?" I asked.

"Actually, I was born in a place north of Bucharest called Moldavia."

"So that's it, that's why I didn't recognize the accent," I exclaimed. "You're Romanian."

The young man paused for a moment, then said, "Yes, more or less."

I realize now that he was probably a Csángó, and that he might well have crossed paths with Krisztián Fodor. In the late 1990s Krisztián, 37, began hiring groups of his fellow Moldavian Csángós for foreign contractors and accompanying them overseas, mostly to Israel. A neighbor of Bibi's in Arini, he had started out as a construction hand himself, as one of tens of thousands of ethnic Hungarians from Romania who are employed in Hungary. Many more work in western Europe, Africa, and the Middle East.

Krisztián had been home for 18 months and was about to leave again for Tel Aviv with 50 men. They would earn $1,200 a month there plus lodging; in Moldavia, if they were lucky enough to have a job, the pay was seldom a tenth of that.

A lot of the other guest workers in Israel were Chinese, Krisztián told me, and he'd gotten to know some of them over beers on warm Mediterranean evenings. "It changes you, traveling, meeting people from all over the world, learning new things," he said. "It changes how you think about yourself."

In Moldavia, as in the Ghimeş, I'd hardly met a family without a son

In the brush of lips, the press of hips, passions stir in Vladnic during a festival for the village's patron saint. Will young Csángós embrace and defend their culture? The pull of the world may prove too strong, says political scientist Andrew Ludanyi. "To stay a Csángó, you have to live a life of constant challenge to your identity."

abroad. I last saw my plumber on a rain-soaked October morning in Lucca, the capital of the province where I live. He was in line at the immigration office with his wife and toddler son, waiting to apply for legal residence in Italy.

The Csángó story was still unfolding. It was the saga of a wandering tribe a millennium ago, but also of the world we all live in now. A restless world where men and women from points as distant as the South China Sea and Moldavia work side by side thousands of miles from their places of birth, changing how they think about themselves. A world in which what it means to be Italian, German, French—or, for that matter, Hungarian, Romanian, and Csángó—is being constantly redefined.

It is a world where "Who are we?" and "Who owns this land?" are questions with ambiguous answers. □

CELEBRATE CSÁNGÓ CULTURE Experience the Sights & Sounds of Csángó country and find out how these people are struggling to keep their culture alive through religion, language, and music. Then listen to folk tunes from Moldavia at **nationalgeographic.com/magazine/0506**.

NATIONAL GEOGRAPHIC RESEARCH AND EXPLORATION

TAK KONSTANTINOU; TIM MAUGEL (RIGHT)

GRANTEE
Eugenie Clark
Marine Biologist
Sarasota, Florida
"These fish are so fantastic! We don't know any other that act like they do."

Evil-looking under an electron microscope, a quarter-inch-long juvenile convict fish is more mystery than monster. Gaping black "eyes" are really nostrils, and the snaggletoothed mouth eats only plankton.

clues from a CONVICT

Nailing the truth about the elusive convict fish proves tougher than expected.

By Carol Kaufmann
NATIONAL GEOGRAPHIC WRITER

Photographs by Stephen Kogge

Why would an 83-year-old marine biologist famous for up-close work with sharks turn her attention to a fish most people have never seen or even heard of? Because it behaves like no other sea creature Eugenie Clark has encountered in more than six decades of research. So secretive is the so-called convict fish (named for its stripes) that after seven years of study Clark still doesn't know how adults bear their young, or even what they eat. And those are just some of the mysteries.

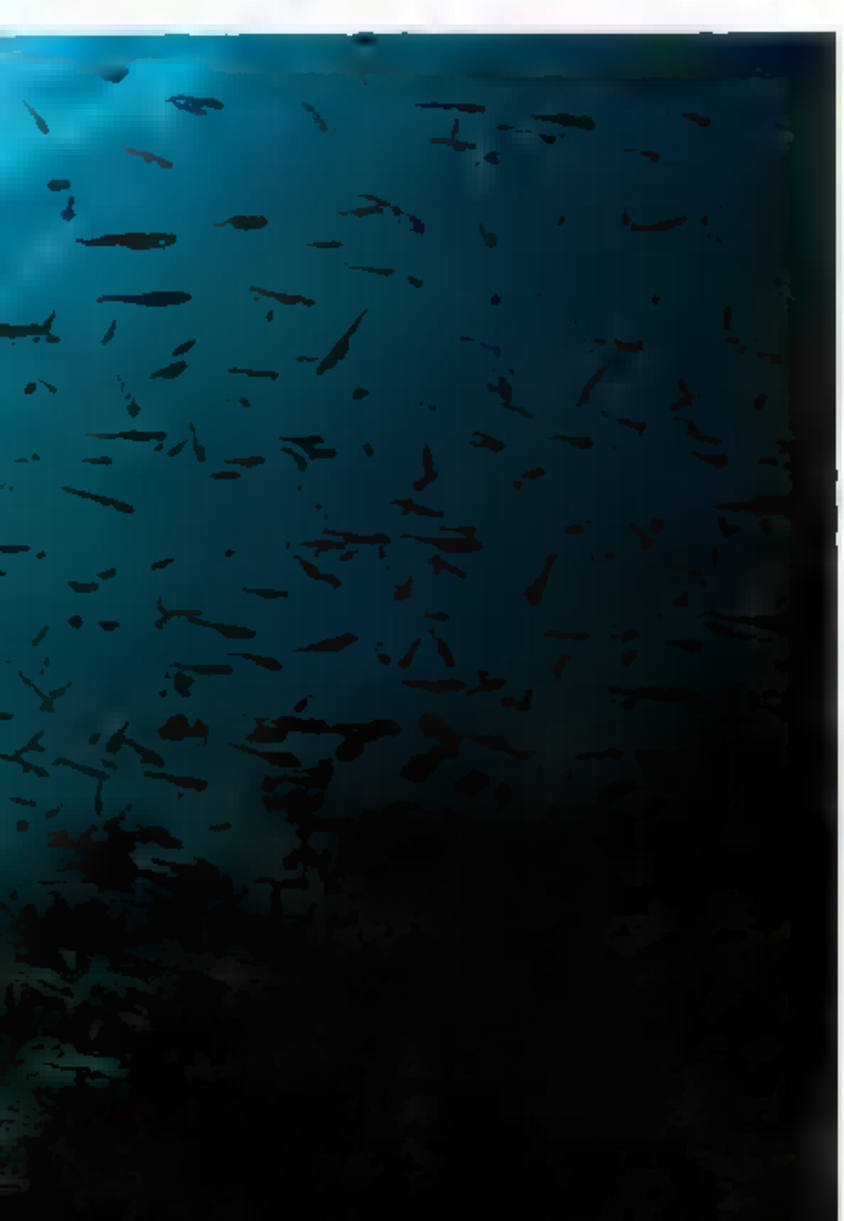
Clark's latest passion was ignited in 1998 off the coast of Papua New Guinea, where she and ■ team of research divers first encountered convict fish. The divers saw clouds of tiny young fish vanish into ■ hole in the coral reef. They also noticed ■ serpent-like head (later discovered to be an adult) poking through the opening. Clark was hooked. "What were these fish, we wondered. I couldn't identify them."

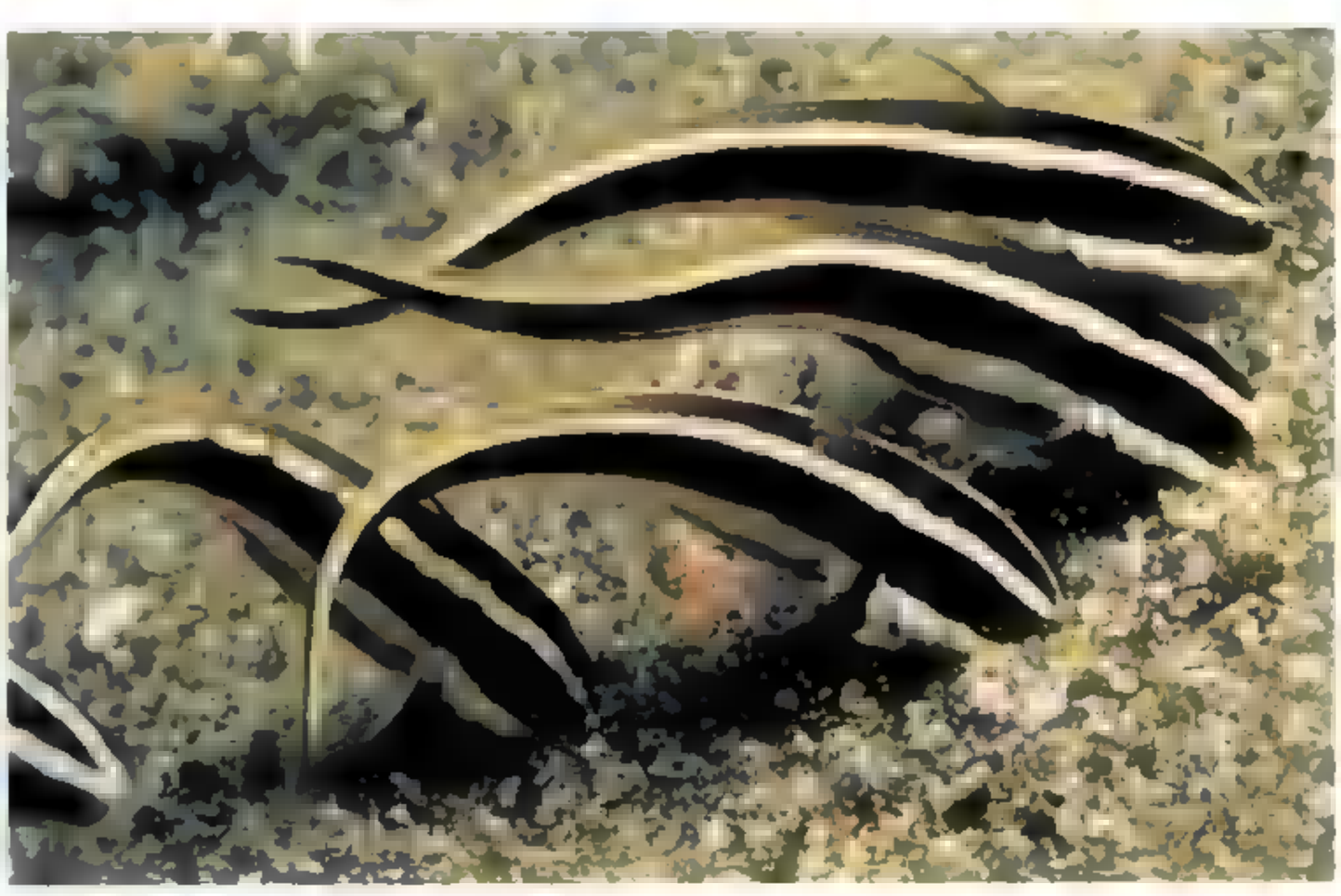
After carefully studying a handful of specimens in her lab, Clark identified the fish as *Pholidichthys leucotaenia*. More often seen in aquariums than

THE PROJECT

STUDY SITES: Mainly in Milne Bay, Papua New Guinea; also Solomon Islands and Borneo
GOALS: To discover how adult fish reproduce and what they eat
BIGGEST REWARD: Learning about a fish no one has studied in the wild
HOURS DIVE-TEAM MEMBERS HAVE SPENT UNDERWATER SINCE 1998: 5,592

Spitting out a mouthful of sand (right), an adult convict fish keeps its burrow entrance clear for offspring. As if inhaled by the reef, thousands of juveniles (below) dive into their burrow for the night.





Juvenile convicts have evolved with a strong resemblance to poisonous striped catfish (above), a look that helps repel potential predators. Convicts were named for their chain-gang stripes, which encircle the body as the fish ages.

in the wild, they are popularly called convict blennies or engineer gobies. But DNA analyses strongly indicate that this fish is not related to the blenny or goby clans—nor to any other known fish family.

Full of questions, Clark's team headed to the Solomon Islands, where it videotaped the early morning spectacle of juveniles exploding like slow-motion fireworks from openings in the seafloor and nearby coral reefs. By day, quarter-inch to four-inch-long juveniles swam as far as 165 feet from their burrows to gulp down plankton.

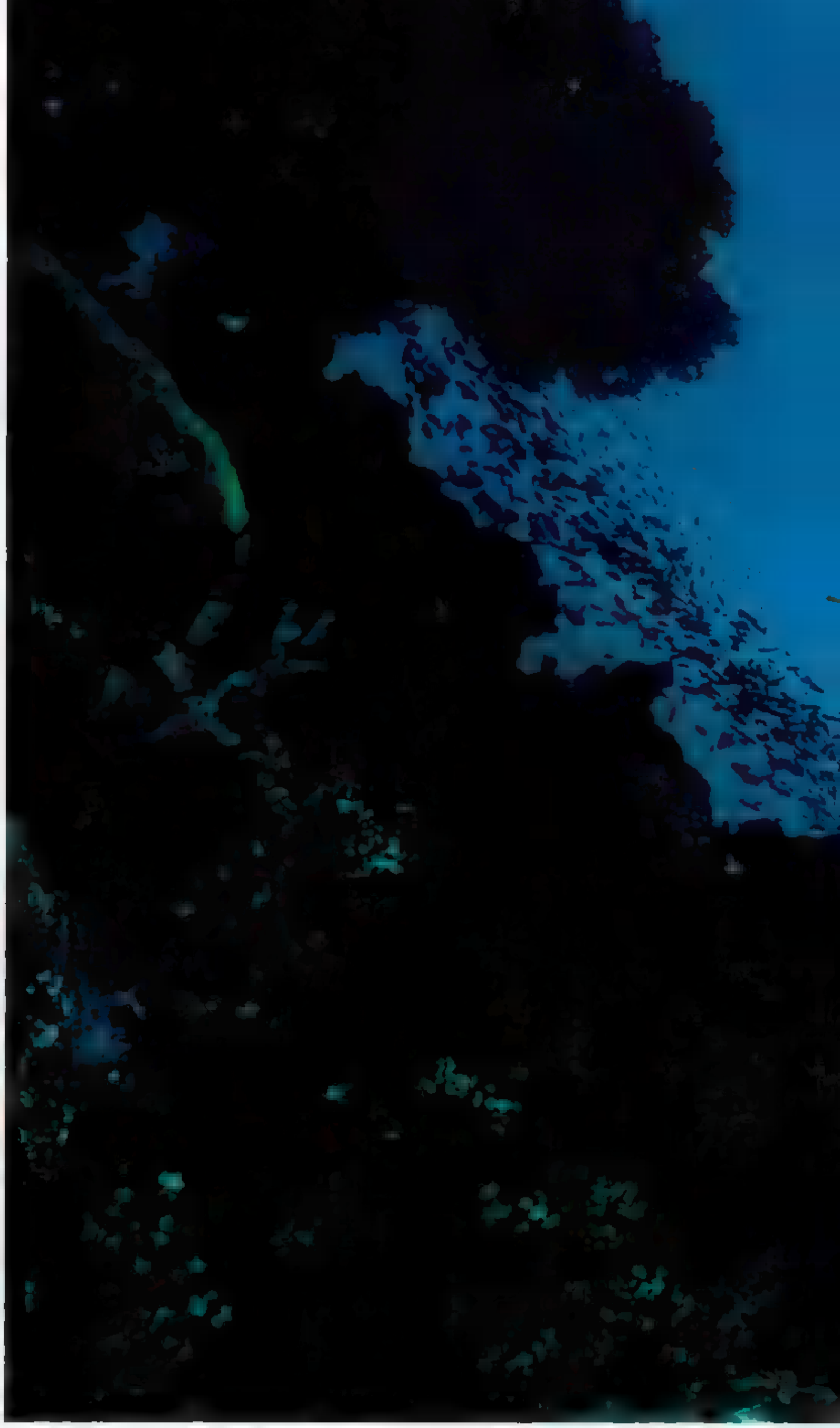
BOB HALSTEAD (LEFT)

Remarkably, at day's end the swarms returned to their holes —a unique behavior for larval fish, which generally float among plankton and drift for miles. "No other coral reef fish have babies that come home to their parents," says Clark.

While the young feed, adults clean house, sticking their heads out just enough to spew mouthfuls of sand or gravel that currents have swept into their tunnels. By nightfall, heaps of debris fan out around the openings. These "sand aprons" may serve as welcome mats that help guide the young home.

"The behavior of this fish in the wild has never been described. It's all new."

—EUGENIE CLARK



To peer inside the private lives of convicts, biologist and photographer Stephen Kogge rigged an endoscope with a tiny video camera and ■ long cable connecting to ■ monitor on board the team's research vessel. Though he compares manipulating the device to "operating a wet noodle," Kogge managed to steer his "burrow cam" inside ■ tunnel.

A labyrinth of chambers Clark estimates to be as long as 20 feet opened off ■ twisting passage. Clusters of young fish literally hung in the maze, their heads attached to the roof by mucous threads so thin they're almost invisible in the water. Juveniles dangled all night. "It's the weirdest looking sight," says Clark. "We don't know why they attach themselves. Perhaps by staying still they conserve oxygen and energy."

Equally odd, adults can grow to nearly two feet, but never seem to leave the tunnel to eat. Yet they often took in mouthfuls of juveniles then spat them back out. "First I thought they were cannibals," says Clark. "Some damselfish eat dead or dying embryos to weed out the weaker links." But when she examined the adults' stomachs, she found only an oozy

green slime. Were the adults eating the juveniles' wastes? Did the parents take offspring into their mouths to protect them from danger? Maybe the young fish regurgitate digested plankton into their parents. If so, Clark says, this would be the first example of fish offspring feeding adults.

Despite a battle with cancer, Clark remains immersed in her convict research. At the Mote Marine Laboratory in Sarasota, Florida, Clark is observing specimens in tanks equipped with mirrors and see-through burrows (made from wine bottles) to learn how adults get enough nutrients to survive and whether they lay eggs or give birth to live young. She hopes to strap on her scuba gear again, as she has for more than half a century, and take to the seas, looking for answers. □

Catching elusive juveniles that dart away at the sight of a net and diver is no easy task. Understanding their behavior is proving even harder. Captive convicts may help solve questions about their survival strategies.

MUG SHOTS To learn more about convict fish, see Web links and resources from our Research Division at **nationalgeographic.com/magazine/0506.**

Fire and

Forecasting the chaos of weather

DATA FROM EARTH OBSERVING SYSTEM AQUA SATELLITE; BRUCE WIELICKI, TAKMENG WONG, AND THE CERES SCIENCE TEAM, NASA LANGLEY RESEARCH CENTER. IMAGE: RETO STOCKLI AND DAVID HERRING, NASA GODDARD SPACE FLIGHT CENTER

Rain

the big picture

A thermal image of Earth on August 1, 2003, shows the Sahara's high temperatures spreading north, engulfing Europe in a heat wave that had lethal effects (p. 108). Such satellite views are among the new tools giving a clearer view of the weather ahead.

I L-L-L-Love New York

Every Sunday during the winter, the Coney Island Polar Bears plunge into the Atlantic for a good cold slap. "We never cancel a swim because of the weather," says Margaret Farley, at right. Meteorologists, though, react to the slightest fluctuations in temperature: One degree can mean the difference between an inch of rain or a foot of snow.

by tim brookes

photographs by jay dickman

One Saturday afternoon last summer, Carrie and Jason Guyette were married on an island on the Vermont side of Lake Champlain. The forecast had been good—partly cloudy, a west wind of 5 to 10 mph—but the weather was even better. The sky was cloudless, the light falling across the lake in rays of silver and blue. "It was the perfect day for a wedding," recalls Suzanne LaBombard, the mother of the bride.

After the newlyweds kissed, the weather began to change. "The wind shifted round to the north and began to pick up," says Jason, "but it wasn't really anything to worry about." The bride and groom climbed into an open carriage for a tour of the island, but after a while the wind was strong enough for the bride to start worrying about her veil, and the driver about her horses. They turned back. "I could see the distinct edge of the front—it looked about two miles south," says Jason.

They returned to the tent, where most of the 200 guests had gathered for the reception. The flaps were whipping, and one or two small pegs were uprooted, but even so, there seemed no reason to worry. The tent, 60 feet by 120 feet in size, was anchored by stakes driven four feet into the ground. "This thing's not going anywhere," the DJ told Jason.

The groom turned, took four paces, and heard a ferocious whoosh behind him. A single devastating gust ripped the tent out of the ground and lifted it over his head. Six-foot stakes flew through the air like javelins. China and glass shattered. A 30-foot main pole swept across the lawn as the family and guests ducked or flung themselves to the ground.

GEOFFREY MCLOUGHLIN

After glorious weather came ominous signs—wind whipping the bridesmaids' dresses under a darkening sky. In minutes a freak storm ripped through this wedding reception, killing one guest and injuring seven. "We'd been watching the forecast," says bride Carrie Guyette. "It was supposed to be a beautiful day."

The gust, which lasted just seconds, had the freakish capriciousness of a tornado. It slammed the tent back down so hard that stakes were driven into the earth again. "It was so fast it was uncanny," Jason says. Seven people were hurt by flying stakes and glass. The groom's step-grandmother was rushed to a hospital in Burlington, where she died of her injuries.

Weather moves on a grand scale, in fronts and storms that can span half a continent. But it is also intensely personal and extremely local. The brilliant weather at the wedding, the terrifying storm at the reception—this is weather on the scale that matters to us. So we demand of meteorologists the near impossible: Understand the drama of the entire planet's atmosphere, and tell us what to expect here. Today. At 4:30 p.m.

Thanks mainly to keener instruments and more powerful computers, forecasters are extending their reach into the uncertain future. These days a forecast

of the daily high temperature five days in advance is likely to be about five degrees off in the United States, two degrees better than in 1975. Flash flood warnings have improved from 7 minutes in 1987 to 47 minutes in 2004. Had last summer's barrage of hurricanes along the Gulf Coast and Florida struck 30 years ago, landfall predictions three days ahead could have been off by as much as 475 miles. By last year the average error had been cut by nearly 300 miles, allowing more selective evacuations.

Yet because the tiniest changes in the atmosphere can produce radical changes in weather, the perfect forecast is tantalizingly elusive. We may never be able to anticipate a hurricane's every move. And the smallest, fastest changing weather events, like that wedding-day storm, may always be capable of blindsiding us.

"Forecasting is still an inexact science," says Charles McGill, who works in the Burlington

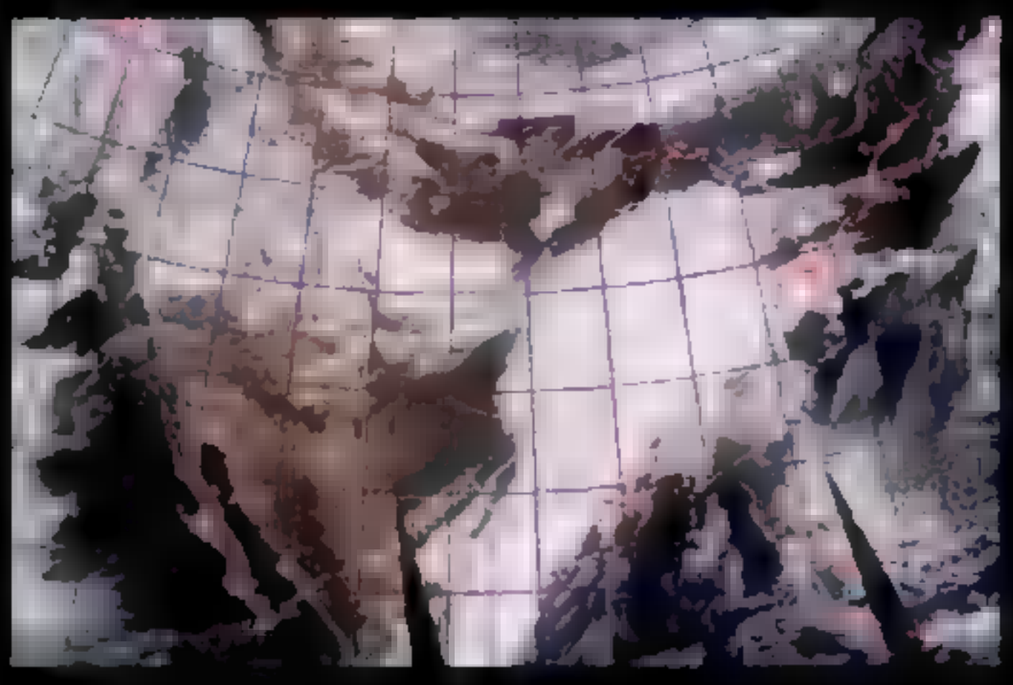
as the world churns

A thunderstorm in Kansas has the same basic ingredients as any weather system: moisture, heat, and air pressure. What varies is how, when, and where they mix—creating a stunningly complex atmospheric stew.

office of NOAA's National Weather Service (NWS). A day before the wedding, the office had predicted storms for late in the evening, but not for that afternoon. "Maybe someday the forecast models will be good enough to pinpoint when and where individual thunderstorms will occur, but I think that day is a long way away."

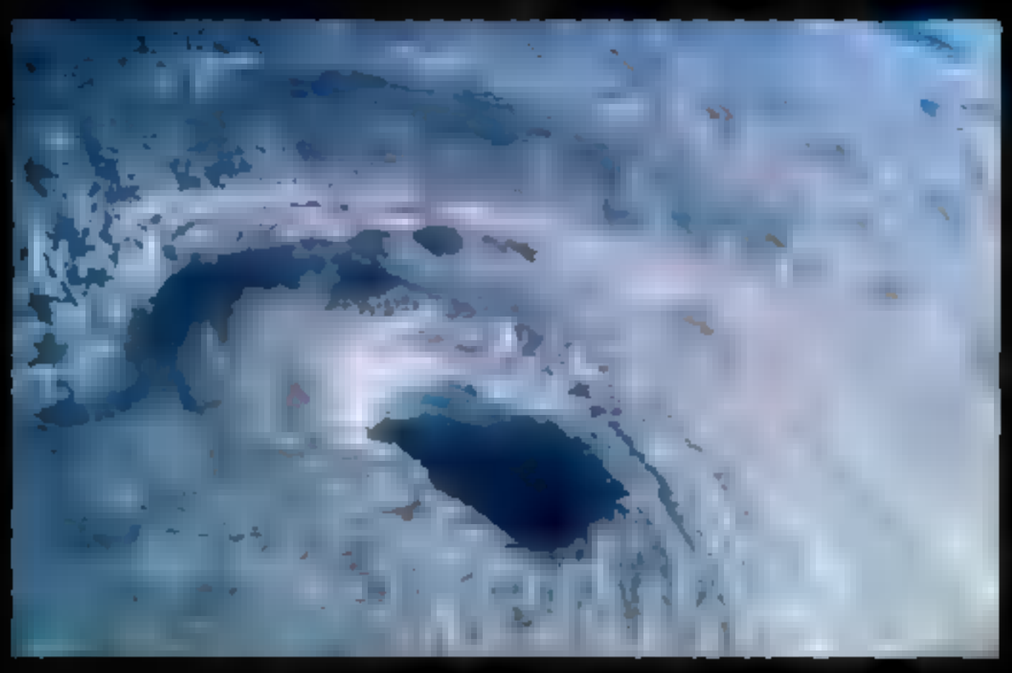
All it takes to create weather is air and solar heating. Then things get complicated. Some of the sun's energy is reflected by clouds; some heats land masses and oceans. Air warmed in the tropics becomes less dense, rises, and heads toward

How accurate is today's forecast?



ROUTINE DAY Satellite images now help meteorologists make forecasts 72 hours in advance that are as reliable as the 36-hour forecasts of 25 years ago.

TORNADOES Scientists can identify and track weather systems that might produce tornadoes, but predicting precisely where one will touch down remains impossible.



HURRICANES Forecasts of where a hurricane will hit have improved 50 percent in the past 15 years. But wind-speed predictions have lagged. The hurdle? Getting sufficient data from inside a storm.

NATIONAL WEATHER SERVICE (TOP); ERIC NGUYEN, JHR REED PHOTOGRAPHY (MIDDLE); INTERNATIONAL SPACE STATION AND NASA

the Poles. Along the way it cools, its freight of moisture condensing into clouds and falling as precipitation. Earth's rotation causes the air currents to swerve right in the Northern Hemisphere and left in the Southern. Mountain ranges, ocean currents, and the high-altitude jet streams meandering around the globe at 200 mph or more all shape the broad circulation pattern. Add local variations in temperature, humidity, and pressure, and the result is the weather we feel on the cheek or read in the clouds.

Much of the physics involved has been understood for decades, even centuries. Yet those forces combine in so many ways, obeying so many variables, that weather is like a summer cumulus: Its stately progress across the sky seems entirely predictable, but each wisp and tentacle seems to have a life of its own, erratic and seemingly random.

Prediction efforts began where they were most needed. In 17th-century Britain, for example, Edmond Halley of comet fame mapped the trade winds and the Asian monsoon as an aid to sailors. Typhoon-prone Japan has a mountainous landscape that crowds its people and industry near the coasts, where they are vulnerable to landslides and storm surges. As a result the Japan Meteorological Agency has become a leader in forecasting typhoons in the western North Pacific and the South China Sea.

In North America the impetus for forecasting was savage weather, such as a storm that damaged a house of worship in Connecticut and inspired a sermon titled "God Sometimes Answers His People by Terrible Things in Righteousness: A Discourse Occasioned by that Awful Thunder-Clap Which Struck the Meeting-House in N. London, August 31st 1735." The United States, with its vast landmass and range of climates and terrain, suffers from hailstorms, blizzards, flash floods, and the world's highest incidence of tornadoes—492 of them in May 2004 alone. Fifty million people live in coastal counties prone to hurricanes. Accurate forecasting can mean the difference between prosperity and ruin, life and death.

To predict what the weather will be, you need to know what it is right now—what meteorologists call current conditions. This is one of meteorology's toughest tasks. At weather stations like the Mount Washington Observatory, at 6,288 feet on the highest peak in New Hampshire's White

Mountains, current conditions are observed the old-fashioned way: by going out into them.

Guidebooks like to call Mount Washington "home of the world's worst weather," and the boast seemed plausible one winter night. The wind was peaking above 90 mph—hurricane force. Chunks of rime ice were crashing against the observatory windows. Steve Bailey, one of the weather observers, suited up, hung a small flashlight around his neck, and picked up an empty precipitation can—a hip-tall metal cylinder for catching rain or, tonight, snow.

He was setting off to collect and replace another can that had been out in the weather for six hours, a hundred yards from the observatory on the ice-clad mountaintop. "If the winds equal your weight, they can knock you down," he said, laughing. "I'm going to run."

I took off after him, and—wham! The wind stopped me dead. It felt like solid air. Bailey's flashlight was a glowworm, somewhere ahead in the dark, but by now he had switched cans and was running back, hugging the other cylinder.

Indoors, with boots, coat, mittens, and goggles off, he picked up his slide rule. "There's a lot of talking to yourself in this job. Dew point of 23.4 converts to what in Celsius? Height of cloud above station . . . 7,000 to 8,000 feet . . . air pressure . . . three point one . . . patchy cloud cover . . . high today was 29.9 . . . depth of snow on the ground—that's a real guess."

After 15 minutes, Bailey was ready to send his report—this extraordinary weather compressed into code and numbers—to the National Weather Service. He turned to the monitor and typed in a data string.

The modem twittered.

The dispatch from Mount Washington joined the blizzard of data that descends each day on the National Centers for Environmental Prediction (NCEP), nine forecasting offices that come under the umbrella, so to speak, of the National Weather Service. (Europe also combines some meteorological efforts, at the European Centre for Medium-Range Weather Forecasts outside London, which specializes in forecasts that look

sticking to it

Since 1930 Richard Hendrickson has sent his daily weather observations, including inches of snowfall, from his Long Island farm to the National Weather Service, a major hub for meteorological data. "They just set up some new automatic instruments here, which are not always accurate," he says. "But I am."

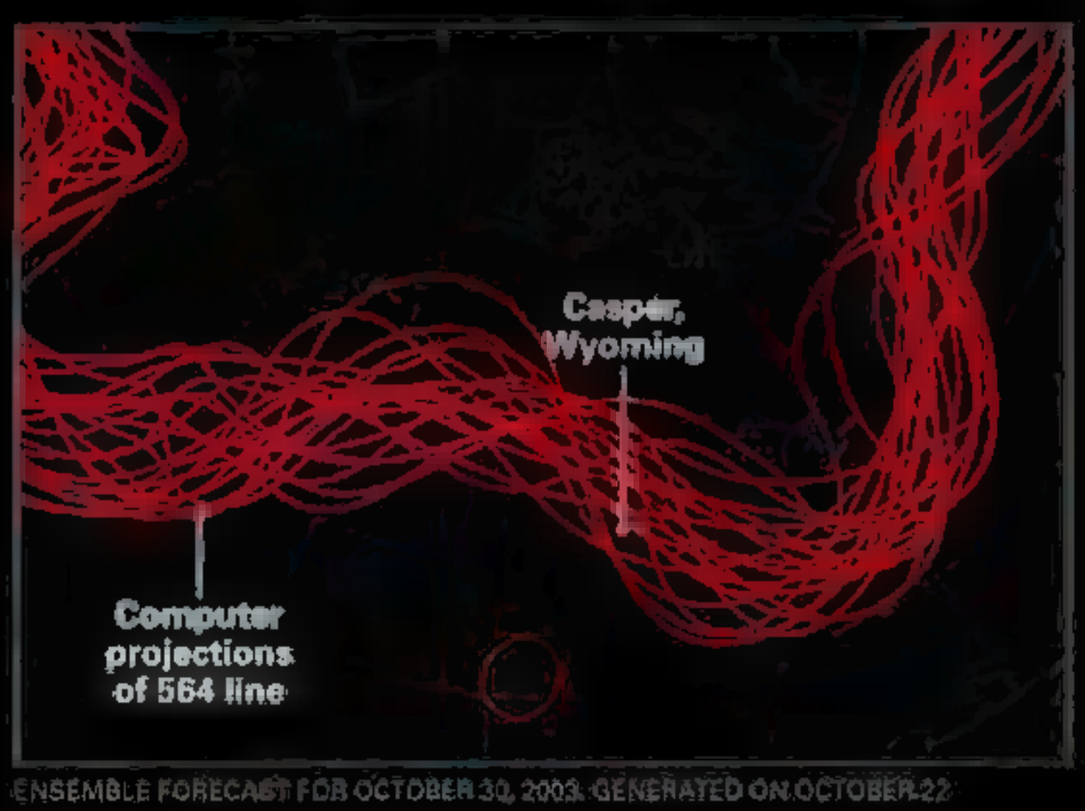
from chaos to your local forecast

it's not a straight line

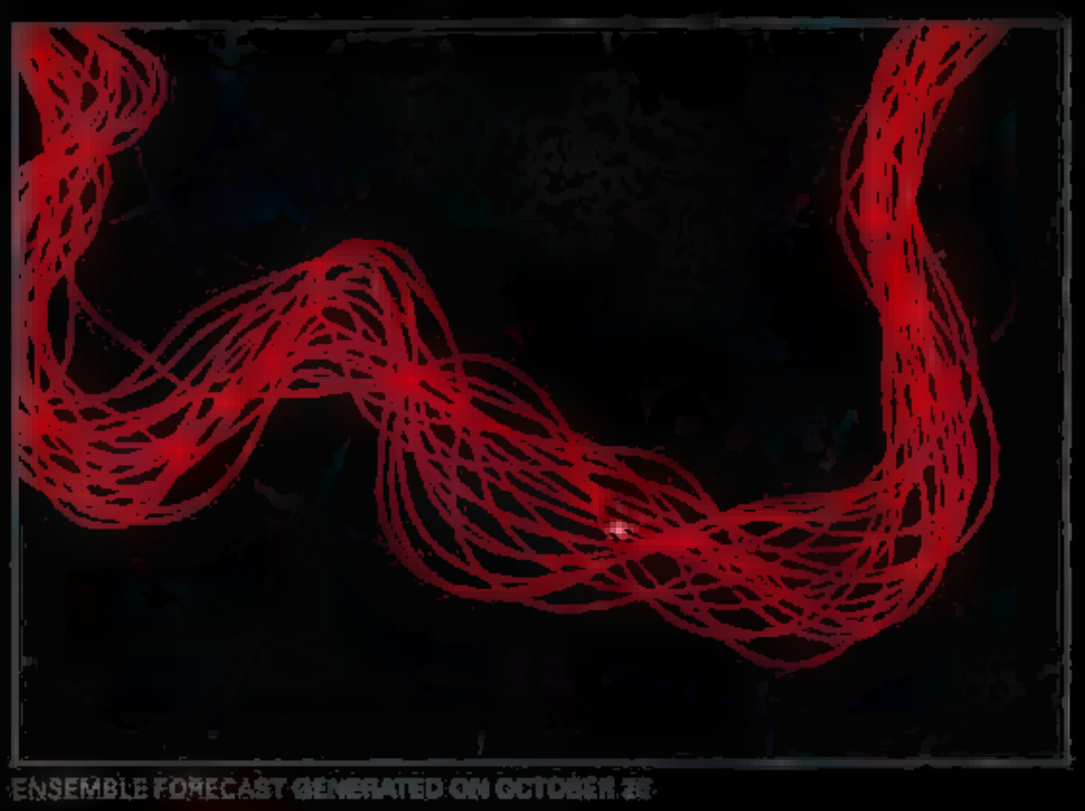
Small things can have enormous consequences. That was the thrust of meteorologist Ed Lorenz's influential 1972 lecture, "Predictability: Does the Flap of a Butterfly's Wings in Brazil Set Off a Tornado in Texas?" Lorenz argued that complex systems like the Earth's atmosphere can be dramatically altered by seemingly insignificant factors—a puff of wind here, an extra degree of warmth there. That poses a challenge for weather forecasters.

Meteorologists begin with a set of initial conditions—data meant to capture the state of the atmosphere at one point in time. The problem is, these readings are an incomplete picture of reality and inevitably include errors. Fed into a computer model, the data yield a short-term forecast that's slightly inaccurate, which is used to generate a midterm prediction that's further off target, until small mistakes grow into huge ones. To address this problem, meteorologists run multiple forecasts using slightly different initial conditions. The result is an ensemble forecast—a bundle of predictions giving a range of possible outcomes. Forecasters look for a consensus in the results.

Consider one day—October 30, 2003—and one place—Casper, Wyoming. A week of ensemble forecasts predicting the position of a key air pressure line (sequence below), along with a last-minute prediction of wind and precipitation (right), helped meteorologists make their call. But somewhere a butterfly was flapping.



ENSEMBLE FORECAST FOR OCTOBER 30, 2003, GENERATED ON OCTOBER 22

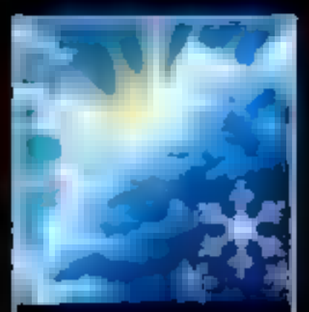


ENSEMBLE FORECAST GENERATED ON OCTOBER 26

Mostly clear
Long-term outlook for Casper on October 30

7 days ahead

A favorable outlook for Casper drew on ensemble forecasts made a day earlier (above). They predicted the position of the 564 line, a line of constant air pressure (at an altitude of 5,640 meters) that often tracks winter storms. Most of the forecasts put the storms well to the north.

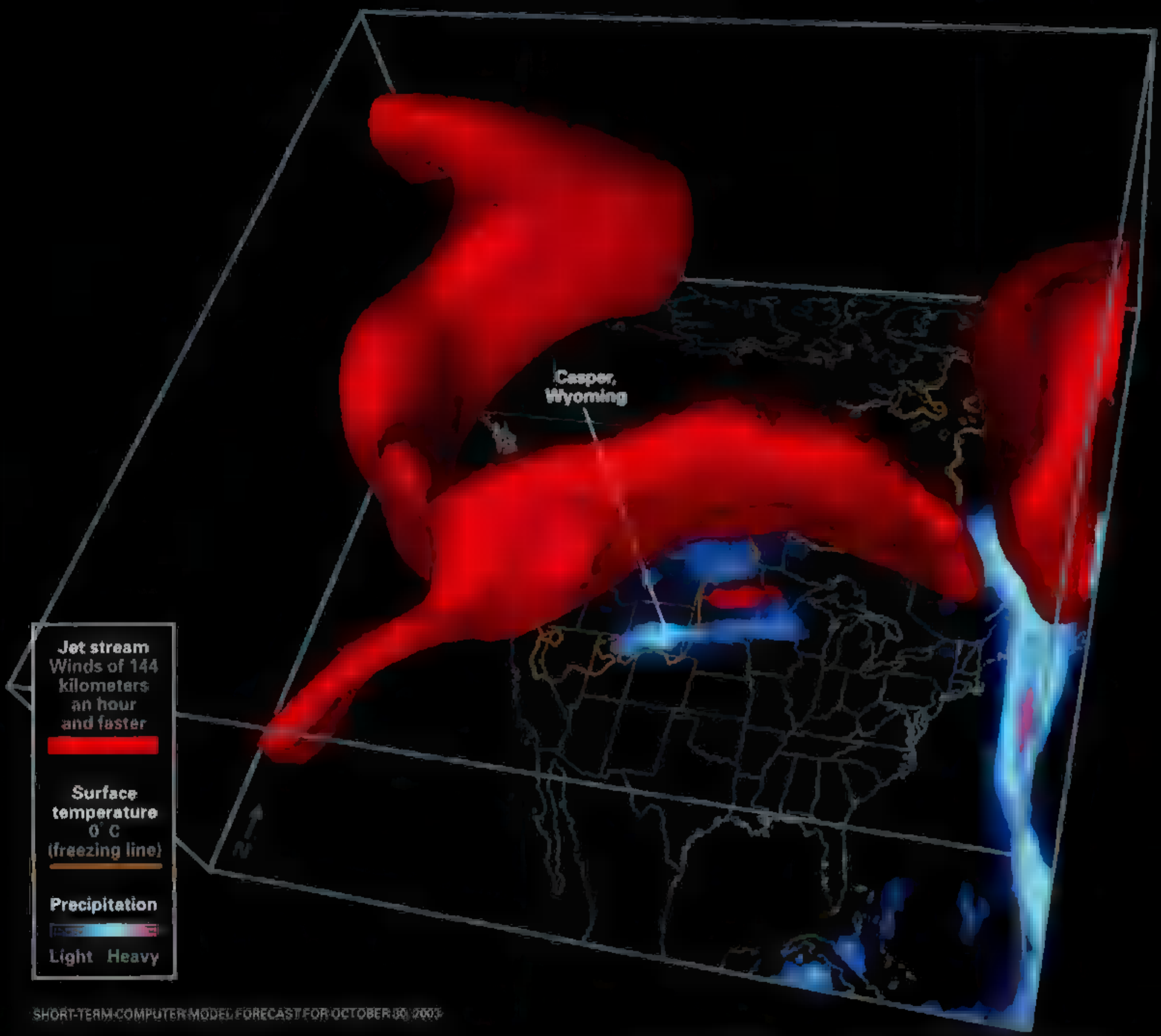


Snow possible
Forecast for Casper on October 30

4 days ahead

Closer to the target day, data errors have less chance to throw off the computer forecasts. One emerging pattern: Predictions for the 564 line are moving south (above), which may leave Casper in a low-pressure trough that could suck in cold air from Canada and bring snow.

ART BY SHAWN GOULD. COMPUTER MODELING SOURCES: ZOLTAN TOTH AND JORDAN ALPERT, NATIONAL WEATHER SERVICE, NOAA; TIMOTHY MARCHOK, GEOPHYSICAL FLUID DYNAMICS LABORATORY, NOAA. LOCAL FORECASTS BY DAY WEATHER, INC. CONSULTANT: DHANURJAY PATIL, UNIVERSITY OF MARYLAND



SHORT-TERM COMPUTER MODEL FORECAST FOR OCTOBER 30, 2003

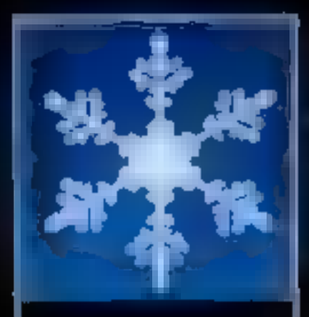
ENSEMBLE FORECAST GENERATED ON OCTOBER 28

DAN CEPEDA, CASPER *STAR-TRIBUNE*

Snow showers
Forecast for Casper on October 30

1 day ahead

The ensemble now speaks with a single voice, as does the weather page of the Casper *Star-Tribune*: "Tomorrow: Cold and breezy with snow showers likely . . . amounts could vary greatly from one location to another." One wild card: how much moisture is in the air.



Snowstorm
Actual weather in Casper on October 30

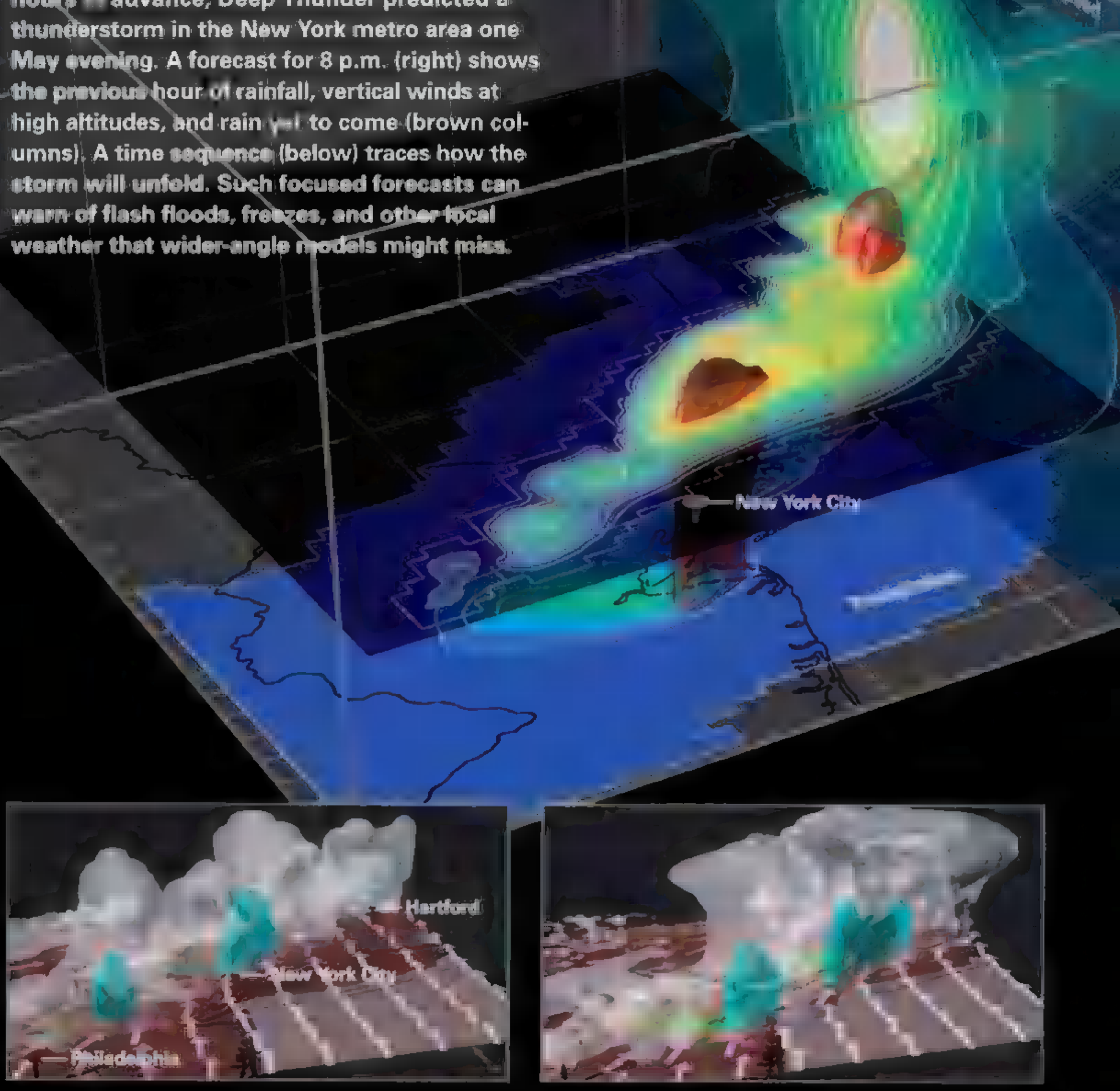
wh[illegible] happened?

A 20-inch snowfall in Casper blindsided forecasters who underestimated how much moisture had been added by the jet stream (top) and low-level winds. To sharpen short-term forecasts, some meteorologists now use models with a tighter geographic focus (following pages).

predictions on the spot

scenes from a storm

Slicing and dicing a blizzard of data, IBM's Deep Thunder computer model generates short-term 3-D forecasts of local weather. Working eight hours in advance, Deep Thunder predicted a thunderstorm in the New York metro area one May evening. A forecast for 8 p.m. (right) shows the previous hour of rainfall, vertical winds at high altitudes, and rain yet to come (brown columns). A time sequence (below) traces how the storm will unfold. Such focused forecasts can warn of flash floods, freezes, and other local weather that wider-angle models might miss.



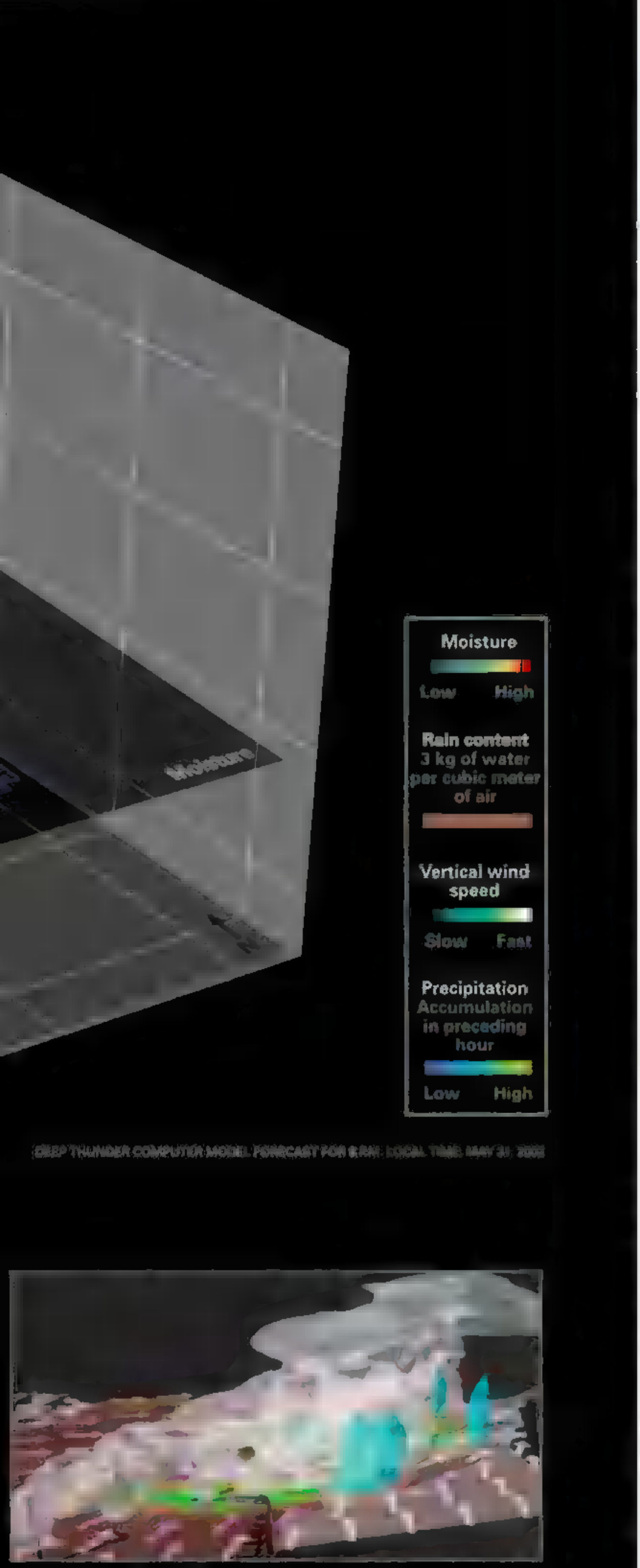
4 p.m. the buildup

Early forecasts called for a warm, humid day. But as a cold front moved in, winds shifted (arrows) and moisture rose, forming clouds. At this point the model correctly predicted that turbulent zones of rising air (blue) would form at the storm's core.

8 p.m. the peak

As the thunderstorm pushed eastward, its anvil-shaped clouds were predicted to dump rain (green trail)—as much as two inches in some areas. After the actual storm, radar data confirmed that this part of the forecast was right on target.

COMPUTER MODELS BY TONY PHANO AND LLOYD TREINISH, THOMAS J. WATSON RESEARCH CENTER, IBM



DEEP THUNDER COMPUTER MODEL FORECAST FOR 6 P.M. LOCAL TIME, MAY 31, 2002

9 p.m. the decline

Drained of its energy, the storm drifted away in this view from the model. The forecast was at most 30 minutes off, says IBM's Lloyd Treinish. "To learn what went wrong, we sometimes plug data from the actual storm back into the model and run it again."

ahead from two days to more than a week.)

Each day the NWS takes in 192,000 observations from surface stations, 2,700 observations from ships, 18,000 from weather buoys, 115,000 from aircraft, about 250,000 from balloons, and 140 million from satellites. Other data, in countless bytes, arrive from instrument networks abroad. Yet all this isn't enough.

The computer models that are the mainstay of current forecasting require even more data, in tidier form: readings from points on a uniform grid extending around the globe and up into the atmosphere, updated every hour or, better, every minute. That's unattainable in the real world. Satellites have trouble seeing through thick clouds and can't map winds in detail. Weather stations, balloons, aircraft, and ships aren't evenly spaced around the globe, and in many areas—vast swaths of poorer continents such as Africa—ground readings are sparse.

To fill out those observations and create a perfect starting point, meteorologists take their best recent picture of the atmosphere and project it forward in time. The result is a "forecast" of the present, which helps fill the data gaps, completing a snapshot of the current weather at every point on the imaginary global grid. It's generated with the same computer tools that allow meteorologists to look into the future—an approach called numerical modeling.

The time machine is a computer model of the atmosphere, built not from air and water vapor but from data and equations. The equations describe the key processes that govern weather, such as airflow, evaporation, Earth's rotation, and the release of heat as water condenses or freezes. When meteorologists plug in data on atmospheric conditions, then run the equations, the model predicts how the atmosphere will evolve. It lets forecasters ask: If this is what the atmosphere is doing now, what will it be doing in one minute? And then again one minute after that?

"You keep taking these baby steps forward in time," solving and re-solving the equations, explains James Hoke, director of NCEP's Hydrometeorological Prediction Center, which does the nation's general-purpose forecasting. At each step, the model computes weather conditions at all points on that imaginary global grid. The process lets meteorologists generate a full picture of current conditions, then carry

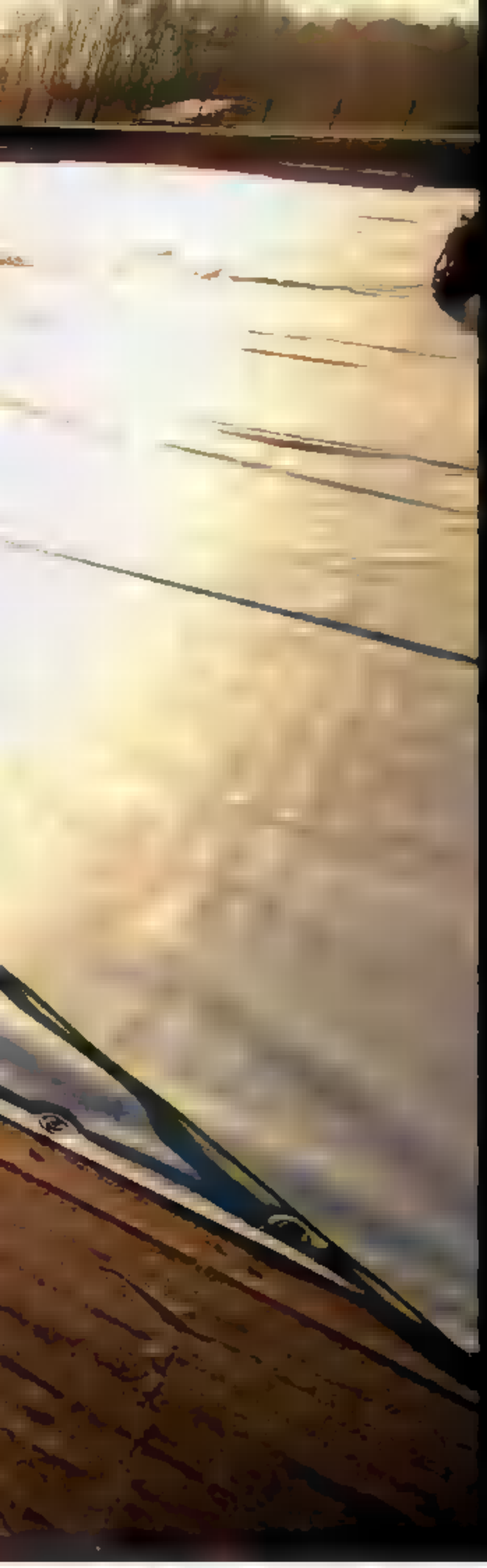
it forward in time to create a forecast. Some models push as far as 16 days into the future, though by that point the accuracy is so diluted that about all they can say is whether the temperature will be above or below the normal monthly average.

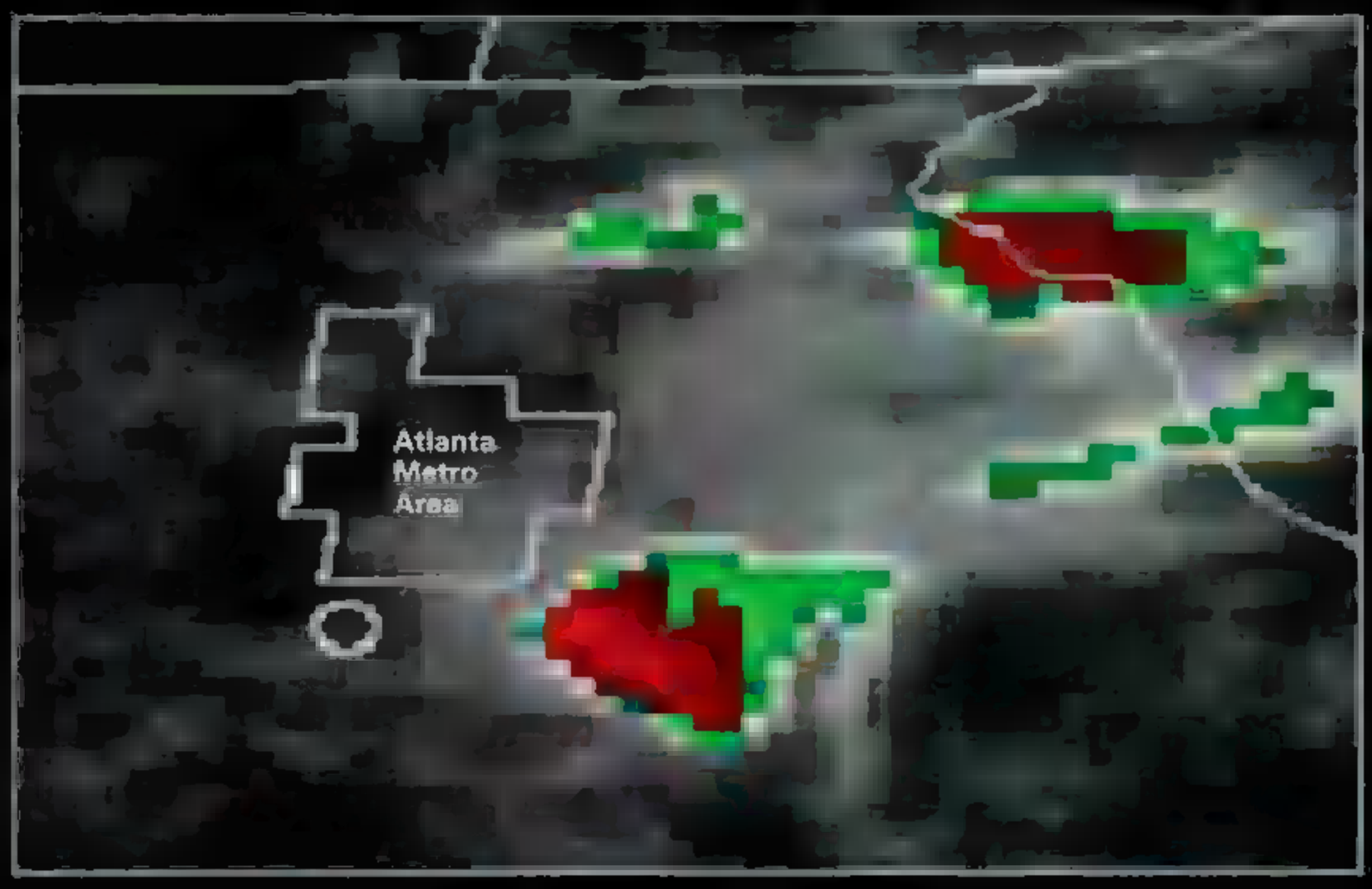
Even baby-stepping into the future takes brute-force computing. "We've always known what equations we should use," says Stacy Stewart of the National Hurricane Center in Miami. But early computers couldn't run a model fast enough for useful predictions. "You'd get forecasts three days after you needed them."

NCEP's computer center in Gaithersburg, Maryland, now crunches numbers in one of the most powerful weather-forecasting engines in the world, a supercomputer called Blue. (A backup, housed elsewhere, is called White, and researchers refine their models on a third machine called Red.) Resembling a warehouse filled with high-tech filing cabinets, the new machine isn't running at full speed yet. But by 2009 it will handle 8.6 trillion calculations—15,000 years' work with a handheld calculator—in a second.

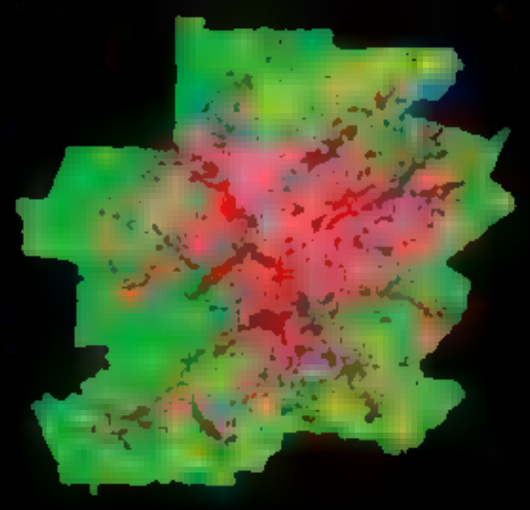
Yet even the most sophisticated computer models drastically simplify the real atmosphere. Most track conditions at points tens of miles apart, even though actual weather can vary widely within only a couple of miles—the size of a thunderstorm. The models also have biases: Some do better with hurricanes, while others are better at predicting winter weather, such as ice storms. Forecasters try to compensate by consulting different models, like patients getting second opinions. All that means extra number crunching.

Something called the butterfly effect adds to the burden. In 1972 Ed Lorenz, a meteorologist at MIT, used the atmosphere to illustrate chaos theory—the idea that tiny fluctuations can, over time, have outsize effects. He suggested that the gentlest breeze from a butterfly closing its wings on one side of the planet could cause a storm on the other. It's an exaggeration, with a measure of





escape from "heat island"



In burgeoning Atlanta (right), green space is giving way to asphalt and other artificial surfaces that absorb daytime solar heat, then release it at night. This heat fuels thunderstorms (colored areas in satellite image, above) downwind of the city. Reflective roofing (left) helps some businesses trim cooling costs and may reduce the city's impact on local weather.

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE; NASA MARSHALL SPACE FLIGHT CENTER (TOP); GALE QUATTROCHI, NASA MARSHALL SPACE FLIGHT CENTER (INSET)

truth: Factors so small that they get lost—in measurement gaps or errors, or in the models' shortcuts—can make a major difference in the weather.

A small wind shift, for example, might send a storm veering miles from its predicted course. In winter "a difference of a fraction of a degree can make all the difference in the world as to whether you get all rain, or all snow, or freezing rain, or sleet," Hoke says. "That small difference has a huge impact on millions of people."

To address the butterfly effect, forecasters rely on a strategy called ensemble forecasting. Starting with one basic set of initial conditions, they run multiple forecasts—as many as 50 at the European Centre for Medium-Range Weather Forecasts, the world leader in ensemble forecasting. Each begins with a slightly different "perturbation"—a change of a mile an hour in wind, a degree in temperature, a percentage point in humidity. The forecast becomes statistical: In, say, 43 of the 50 computer runs snow develops, while in seven it rains. That's why so many forecasts use words such as "possible" or "likely," and speak of the percentage probability of precipitation.

Computers don't have the last word. After the models have their say, their output is converted to user-friendly graphics and, in the U.S., sent to the Hydrometeorological Prediction Center (HPC), on the fourth floor of a nondescript building in Camp Springs, Maryland. There flesh-and-blood meteorologists second-guess the machines.

One fall day Bruce Terry was the lead forecaster on duty, sitting at a workstation flanked by computer screens. The windows were shaded to keep out glare, hiding the weather outside. All the action was on the screens. On one a radar readout showed a blue-green smear curving up from the southern plains states toward the Ohio Valley; another displayed a satellite view of the same region, veiled in gray cloud. On that particular day Terry's job was to decide where the rain would


JAY DICKMAN WITH LUKE RAYMOND

news flash: it's a great day out on the bay

To catch the perfect breeze, windsurfers can sign up for services that pinpoint where the wind is blowing and how hard. Alerts are zapped to subscribers via the Web or cell phone. That's key on San Francisco Bay, where the wind can vary wildly from one mile to the next

fall, and how much. Forecasting precipitation, he said, is one of his greatest challenges.

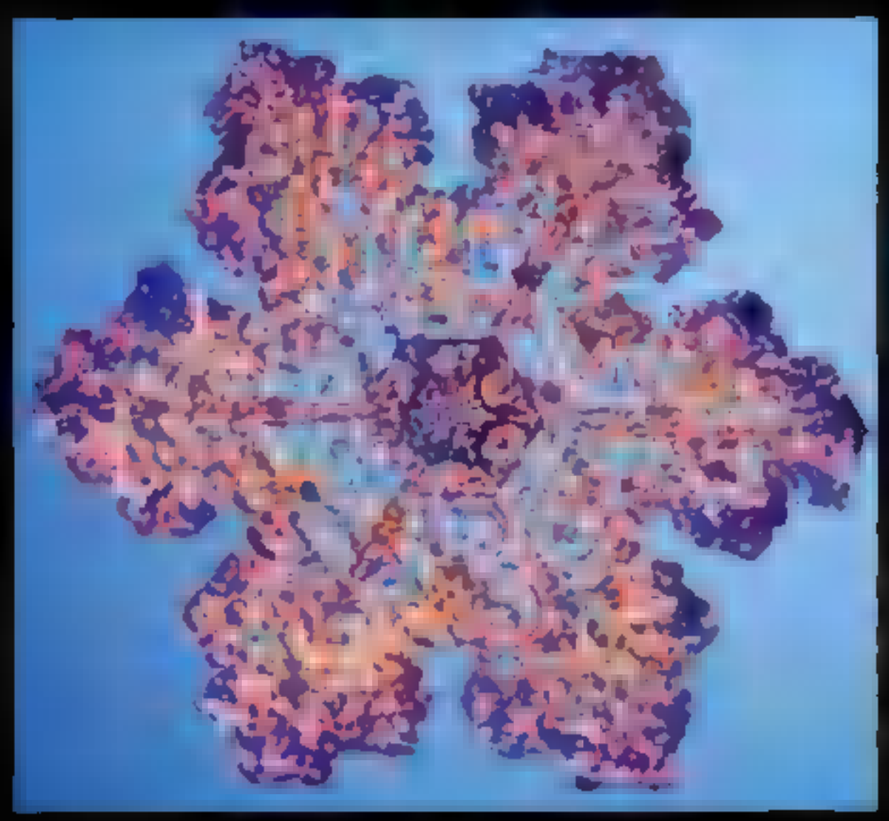
At least it wasn't summer, when thunderstorms, too small for the computer models to capture, deliver most of the rain. "You'll have an inch of rain here, but five miles down the road you get nothing," said Terry. Precipitation forecasts are easier in the cool seasons, when weather systems tend to be large and well organized, like this one.

He stared at the screen some more. "It's really important to be able to recognize the biases in the models," he said. Right now, comparing the rain on the screen with model forecasts, Terry sensed a bias was at work. "In the first six hours of the forecast, the models never seem to have enough precipitation." His experience told him this storm system was ripe for heavy rain. A patch of low pressure was lingering over the southern Rockies, drawing wet air from the Gulf of Mexico and supercharging the storm with moisture.

The computer had given him its best guess, but now it was time to follow his instincts. He frowned and used his computer drafting tool to sketch in corrected precipitation estimates, calling for heavier rain. By morning, he forecast, the core of the storm would be drenching Washington, D.C., and the leading edge would be over New England, promising snow. The next day, commuters would find he was right.

"You noticed Bruce was bald?" his colleague Pete Manousos joked. "He pulls his hair out when he does his forecasts."

In fact, what the HPC staff such as Bruce Terry produce is not, officially, a forecast, but "guidance" or "advice" for the 125 local NWS Weather Forecast Offices. It's also grist for commercial forecasters—purveyors of weather "products" such as glossy maps and satellite images for radio, newspapers, TV, and websites. Some even sell specialized forecasts to windsurfers wondering which beach has the best conditions, or to orchid growers needing advance warning of frost.



at the airport, a surer sense of snow

During freezing conditions, how often does a jet need to be de-iced (left) prior to takeoff? "Years ago we'd check the visibility and make an educated guess," says Barb Ries, a de-icing coordinator at United Airlines. But what appears to be light snow can have heavy water content: An encrusted crystal (above left) contains perhaps twice the water of a crystal without such riming (above right). To accurately measure the snow's moisture content, some airlines rely on a new device that collects snowfall, melts it, measures the moisture, and then automatically transmits the data to coordinators like Ries. Such now-casting can help keep planes on schedule—and passengers safe.

PATRICIA RASMUSSEN AND KENNETH LIBRECHT, SNOWCRYSTALS (BOTH ABOVE)

Other forecasters are looking beyond weather to its ripple effects on the infrastructure, environment, and economy. Pilot projects in several states combine winter storm forecasts with data on roads and traffic to help highway departments dispatch the right number of plows and salt trucks to the right highways at the right time. And in Florida, researchers are turning weather prediction into forecasts of fire.

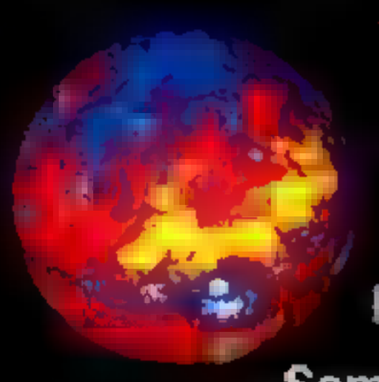
In a conference center at Florida State University, two dozen meteorologists, computer modelers, and foresters lean forward in excitement as Phil Cunningham, a meteorology professor at the university, starts a video. The screen shows a small wildfire nibbling at a Florida woodland. Low flames blacken palmetto and gallberry undergrowth, and a few trees smoke.

Within seconds the smoke pall starts to rotate. Suddenly the flames at the center seem to twist together, then leap upward. An astounding thing is growing, a "fire whirl" that spirals above the treetops, tight and vivid as a tornado.

Wildfires are a major threat to the sprawling suburbs of Florida, where land once cleared for crops now grows scrub and trees, and in the subtropical climate grows them very efficiently. "I've seen trees put on five feet in a year," says Gary Achtemeier, a Forest Service research meteorologist. A long dry spell between December and May, followed by the most intense lightning season in the mainland U.S., adds to the danger.

Deliberate fires, called prescribed burns, can reduce the risk, but only if the weather is right. Hot winds can send the fire spiraling out of control. Calm weather is better—except when a temperature inversion traps the smoke at ground level. Then it can mix with water vapor to form a lethal "superfog" that can steal along low drainages and throw a curtain across a highway.

"Typically these superfogs develop when there's a clear sky, light winds, and unlimited visibility. People are driving 60, 70 miles an hour,



hit by a killer heat wave

In August 2003 temperatures in western Europe soared over 100° F, killing more than 20,000 people, whose bodies filled morgues like one in Lyon, France (right). Some Parisians found a measure of relief from sprinklers (above). Computer climate models predict that global warming could make heat waves and other extreme weather more common in the future. But no model will ever capture the full complexity of weather.

GETTY IMAGES (TOP); FRANCK PREVEL, AP/WIDE WORLD PHOTOS

and they come into one of these drainages, and"—Achtemeier snaps his fingers—"they can't see beyond the hood of their car."

So Cunningham is combining weather forecasts with computer simulations of fire to predict how a prescribed burn might behave. That's not simple, because fire makes its own weather. The fire's updraft, for example, sucks in air and generates winds that fan the flames. But the researchers hope to create a tool for telling foresters where and when to burn, and how the smoke will spread. "In five to eight years," says Al Riebau, the Forest Service's national program leader for atmospheric sciences, "parents of asthmatic children may be able to check on their laptops to see if any smoke is going to be heading their way."

And what's the forecast for forecasting ordinary weather—the cold fronts, drizzle, and sunshine that are the backdrop to most people's lives? Steady improvement, says Richard Anthes, president of the University Corporation for Atmospheric Research in Boulder. By 2025, he says, "numerical predictions in the zero to two-day time frame will be essentially perfect. If the forecast says 12 inches of snow, the actual amount will be in the 10- to 14-inch range." Forecasts of temperatures and storms a week out will be as reliable as two- to three-day forecasts are today —which is to say, right most of the time.

More detailed models and faster computers will drive some progress. Computing-intensive pilot projects in some major U.S. cities, for example, are already forecasting thunderstorms up to 24 hours ahead, to within a couple of miles—useful for airports, though not good enough to guarantee a storm-free picnic or wedding. But better data will be the real key, say meteorologists.

New generations of satellites will help fill the gaps that now hamper forecasts. Starting in December, if plans hold, a joint U.S-Taiwan system called FORMOSAT-3/COSMIC will probe the

atmosphere by eavesdropping on radio signals from the global positioning system's satellite beacons. The six COSMIC satellites will pick up GPS signals that have passed into the atmosphere and back out to space. By analyzing how air temperature and moisture affect the speed of the radio waves, COSMIC will create a global map of these atmospheric properties.

Other satellites will sample the atmosphere with light. A technology called LIDAR (an acronym for "light detection and ranging") works like a light-based radar gun, clocking wind by sending out ■ laser pulse and catching its reflections from air molecules and dust particles. A satellite-borne LIDAR could track winds over the oceans, where measurements are patchy—and where hurricanes and typhoons begin their march to shore.

"If you can cut the uncertainty in the predicted landfall site of a hurricane to a hundred kilometers," says Jim Ryan, a physicist at the University of New Hampshire who is developing a LIDAR, "you can start talking about more intelligent evacuations, instead of sounding alarms over half the eastern seaboard." Next year Ryan hopes to launch ■ balloon-mounted LIDAR—a first step toward a satellite version.

Near the foot of Mount Washington one frigid New Hampshire night, as the last blush of sunset silhouetted the birches, Ryan supervised a LIDAR test. Inside the small, domed observatory an operator threw a switch, and a brilliant pale green line leaped up into the dark sky. Whenever a fleck of dust drifted into the beam, it seemed to spark.

Every few seconds the laser fell dark, then lit up again—the finger of meteorology probing the heavens over and over. □

ROLLING THUNDER Watch the computer animation of a severe-storm forecast for New York (pages 100-101). Then find more photos, plus links and resources chosen by our Research Division, at **nationalgeographic.com/magazine/0506**.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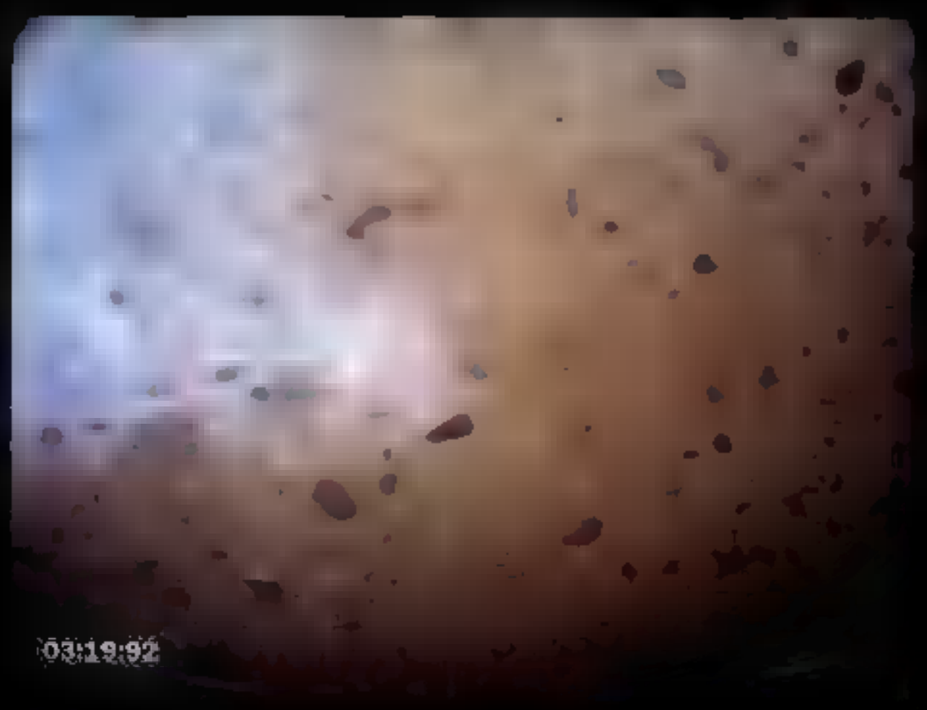
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▶ Watch the first ever inside-tornado video at nationalgeographic.com/magazine/0506.

SIMULATION

43,600 frames, 300-degree view.

Moments after Samaras places pressure sensors and the team drives away (left top), rain starts falling and the tornado cuts like a scythe across a cornfield. Suddenly the tornado strikes the cameras: Cornstalks, rocks, sticks, leaves, and dirt fill the air. As it pushes past the probe, the tornado rolls a piece of farm equipment, snaps trees, and scours a field to bare soil.

Each image, like this stick (above left), contains two superimposed pictures recorded milliseconds apart (above right)—a characteristic of video photography that enabled Samaras to estimate the velocities of objects picked up by the tornado. He matched the position of the stick to a spot where he stood while placing the probe (below) and then used measurements of his body to figure the stick's size and distance traveled. Knowing that the two pictures were taken 16.6 milliseconds apart, he calculated a speed of 71 mph. That's remarkably fast, given the stick's location just inches off the ground. Similarly, he found that a maple leaf (not shown) a few feet off the ground was traveling at 125 mph. Combining many such estimates will make it possible to create detailed pictures of wind speeds—and grasp what is happening inside tornadoes where they meet the ground.

—Karen E. Lange
NATIONAL GEOGRAPHIC WRITER

NGM ART

Distance / Time = Velocity

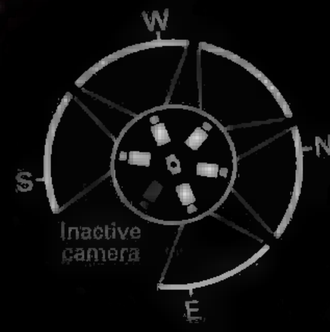
$$\frac{1.72 \text{ feet}}{0.0166 \text{ seconds}} = 104 \text{ feet per second } \textit{or } 71 \text{ miles per hour}$$

DIRECT HIT

A well-placed probe captures the first ever video images inside a tornado.

SEE IT ON THE WEB AT NGM.COM

PHOTOGRAPHS BY TIM SAMARAS



ART BY VLAD DUMITRASCU

Last June 11 Tim Samaras and two colleagues did the near impossible—they chased down a tornado and placed a probe with video cameras directly in its path. Beginning at precisely 2:23 p.m. the team caught images that have—in a breakthrough—made it possible to calculate wind speeds close to the ground, where tornadoes rip through human lives.

Even after his team found the tornado and drove along a dirt road in Iowa to a place they were fairly certain lay in its path, Samaras remained unsure of where exactly he should leave the probe. He stood watching the tornado boil toward him, then, at the last second, he jogged over (right), hefted the 80-pound probe, and shifted it 40 feet to the north. Samaras guessed right: The eye passed just 10 feet from the probe, giving the cameras the closest ever view of the fierce winds turning just off the ground around a tornado's center.

Wind speeds within tornadoes are so difficult to measure directly that scientists must rate tornadoes by the damage they cause. The one Samaras caught plucked up a steel bridge and threw it down in a twisted heap, severe damage that earned it an F3 rating, with estimated maximum wind speeds of 158 to 206 mph. Scientists can measure wind speeds with mobile Doppler radar, but only from a safe distance. Samaras's cameras looked into a part of the tornado long hidden from scientists using Doppler: the bottom 30 feet. Winds at this level flatten houses and hurl cars. Understanding these winds—the tornado's strongest and most erratic—may enable engineers to design better tornado-resistant structures.

A squat steel probe (left) protected Samaras's video cameras—six pointing outward and one up—from annihilation. This Expeditions Council project was supported by your Society membership.

ZipUSA

POSTVILLE, IOWA

52162 Midwest Kosher

BY EMILY YOFFE PHOTOGRAPHS BY CAROLYN DRAKE

What are 250 Hasidic Jews doing in the tiny farm town of Postville? Attracting controversy. At issue is the ritual of kosher slaughter, in which animals are killed with a razor-sharp knife, here tested by Getzel Rubashkin (above). But the locals who once wished the Jews had never arrived have become their biggest defenders.

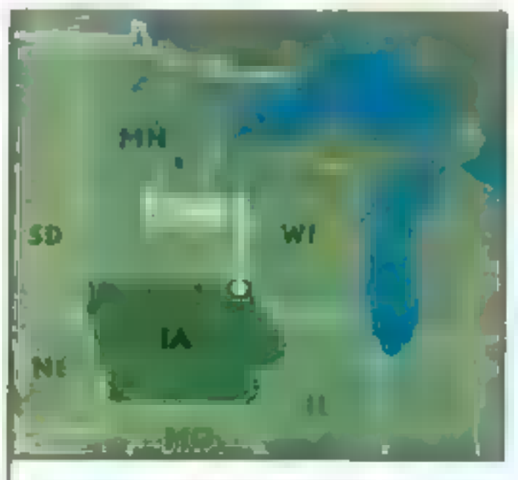
Full beards, skullcaps, and head scarves used to stand out in Postville, but the Hasidic Jews' modest dress (above) is now part of the scenery. When the tight-knit Hasidim began arriving in 1987, they clashed with midwestern norms. "Ripples happen," says local resident Nina Taylor, "but now if they left, we'd miss them."

"Slaughtering an animal is a bloody business," says Sholom Rubashkin, a manager at AgriProcessors, one of the largest kosher meatpacking plants in the country. A video secretly filmed last year in Rubashkin's plant in Postville, Iowa, by People for the Ethical Treatment of Animals (PETA) demonstrates just how bloody. For an animal to be considered kosher, it must be killed by a swift cut across the throat with a perfectly sharpened knife. This ritual slaughter, called shehitah, is designed to ensure that death is nearly instantaneous. But the video shows cows moving, even trying to get up after being cut. PETA says this violates humane slaughtering laws and that the plant should be prosecuted.

Rubashkin says the video, shot over seven weeks, selectively shows those few cases in which a cow, though rendered unconscious, may not look like it was killed instantly—he compares the animal's movements to a chicken with its head cut off. As he takes me on a tour of the chicken-processing side of the slaughterhouse—the birds' featherless bodies clicking along on an overhead conveyor belt—he says the criticism is an attack not only on his company but also on an ancient tradition. "I think PETA is after the shehitah process," he says in a staccato Brooklyn accent that has not softened after years in the Midwest. "They'd love to make it illegal."

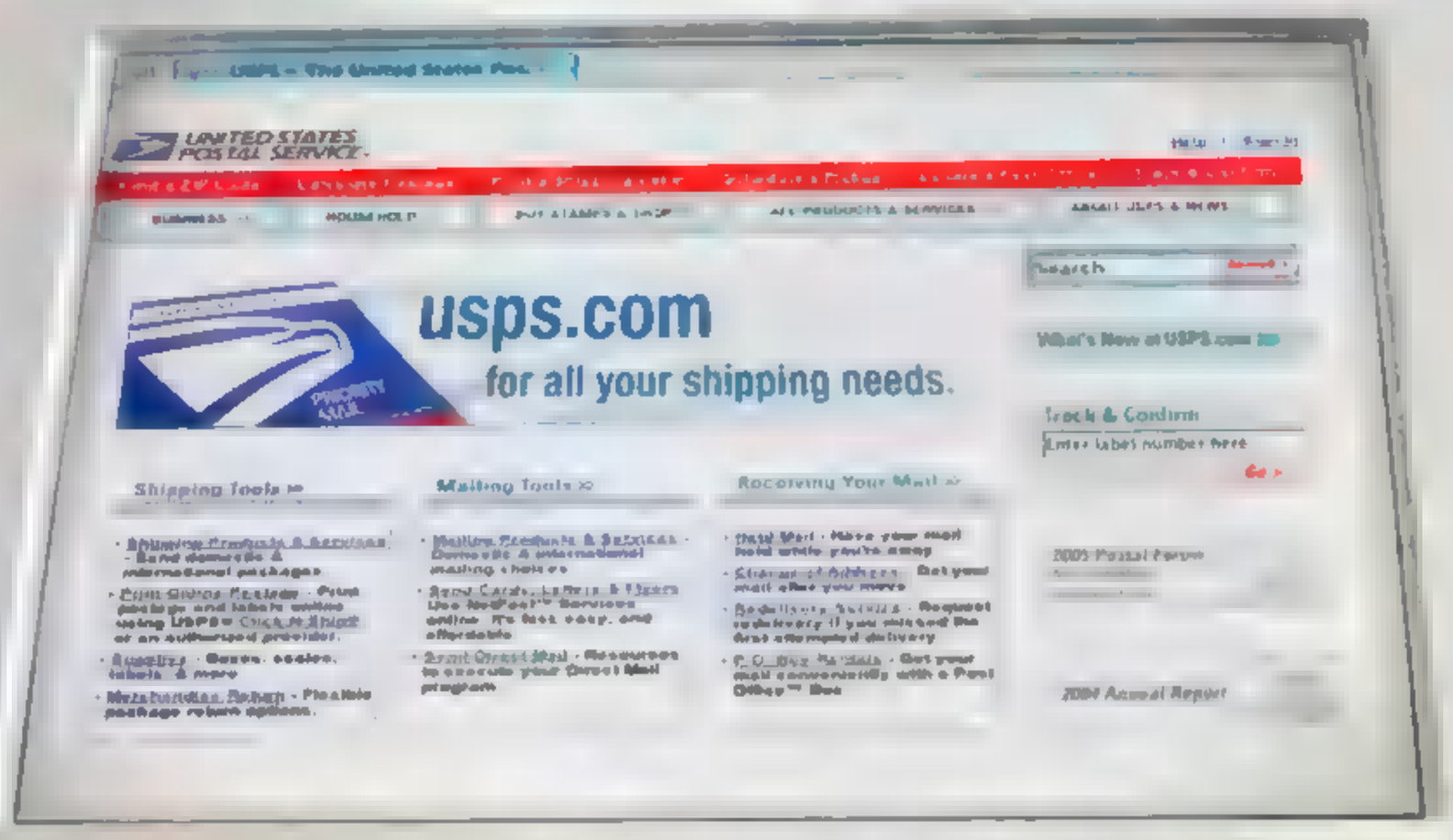
The U.S. Department of Agriculture is now investigating AgriProcessors, and in February PETA launched a national ad campaign against them. This isn't the first time the Rubashkin operation has attracted controversy to Postville. In 1987 Sholom's father, Aaron, purchased the then defunct meat-processing plant, and eventually some 250 Hasidic Jews moved to town. When I ask Rubashkin how the family decided on Postville, he says, "It was divine providence. God wanted us here."

God may have wanted it, but not all the locals did. Farmers of German and Norwegian descent, many of Postville's residents were appalled by the sudden arrival of the Hasidim, with their strange clothes and odd customs. Hasidic men typically wear dark suits, skullcaps, broad-brimmed black hats, and untrimmed beards. Married women wear wigs or kerchiefs to cover their hair. As Orthodox Jews, Hasidim are not allowed to work, or even drive, on the Sabbath. They observe strict kosher dietary



1990 POPULATION: 1,472
2000 POPULATION: 2,273
HASIDIC JEWS: About 250
FOREIGN-BORN RESIDENTS: 752
NATIONAL ANCESTRIES AMONG RESIDENTS: 30
LANGUAGES BROADCAST ON LOCAL RADIO STATION: English, Spanish, Russian, and Hebrew
KOSHER DELIS: 1

MORE THAN JUST A PRETTY INTERFACE.



UNITED STATES POSTAL SERVICE.

At Taste of Postville, the town's annual food festival, Getzel (left, at left) and Mendel Rubashkin show off the *kazachok*, a Russian Cossack dance. But the cousins won't be queuing up to sample the hot dogs and tacos. They eat only meat inspected by a rabbi, like this turkey at AgriProcessors, Postville's meatpacking plant (below), and then declared kosher ("fit" in Hebrew). The slaughterhouse, which jump-started the town's tired economy, has come under fire from an animal rights group.

laws, such as not eating pork or shellfish and not mixing meat and dairy.

When they first arrived, the Hasidim didn't return the greetings of the townspeople. "They brought their New York habits with them," says one resident. Their lawns went unmowed. They drove erratically—a U-turn became known as a Jew-turn. "People accused them of being standoffish," says Ron Taylor, a city councilman. Hasidic Jews see assimilation as a threat to their very existence. Wherever they live, they create a close-knit community and start their own schools. Food often brings people together, but because of their dietary restrictions, the Hasidim can't eat at their neighbors' homes or restaurants or even accept a welcome food basket. "Our dietary laws are different. That's why we're here," Rubashkin says.

With its streets of tidy houses that peter out into endless farmland, Postville offers a classic story of small-town America transformed by newcomers. The image of black-hatted men and their modestly dressed wives emerging from the cornfields on their weekly walk to the synagogue has been irresistible to the media. CNN has been by, as has PBS. In 2000, journalist Stephen Bloom published a book depicting Postville as a town irrevocably riven by cultural misunderstanding.

It doesn't feel that way today. "We learned from the book," says Cheryl Waters, owner of the Beauty Hut hair salon off the town's main street. She insists Postville was never as divided as in Bloom's portrait, but believes the book broke down barriers on both sides.

Take Leigh Rekow, a semi-retired farmer, member of the city council, and a regular at The Bakery, a piece of old Postville where farmers, bankers, and housewives gather each morning—men at one table and women at another—to drink coffee and catch up on the news. Rekow wryly mentions that he's the man in Bloom's book encouraging the Hasidim to depart ("Just don't let the screen door hit you in the butt when you leave") during a zoning dispute a few years ago. So bitter had feelings

Winning two Edward R. Murrow Awards for broadcast journalism isn't easy. But for Donna Renae, nothing worthwhile is. Donna's distinguished career began in the U.S. Navy over 20 years ago at Pearl Harbor, where she wrote for the base newspaper before enrolling in the Department of Defense school of journalism. There, she not only discovered a passion for broadcasting, but also developed the confidence to pursue that passion and work tirelessly to succeed. And we're proud to report that her efforts were not in vain.

DILIGENCE

– DONNA RENAE
UNITED STATES NAVY 1982-1987

become that Sholom Rubashkin was quoted calling Rekow an anti-Semite.

Now Rekow says he's glad the Hasidim came to Postville. "The Jewish people don't cause any problems whatsoever," he says. And the plant has helped turn the town's moribund economy around, employing 700 people from 14 countries and processing more than 100 million dollars worth of livestock a year. Postville's population grew 55 percent in the 1990s to nearly 2,300—about ten times the rate for the rest of the state.

Today half the pupils in Postville's kindergarten are Spanish-speaking—children of workers at AgriProcessors and other nearby plants. The town has both a popular Mexican restaurant and a kosher deli. The visitors center sells gifts representing the mixed heritage of the new Postville, from painted wooden crosses to glass figurines of bar mitzvah boys. Nina Taylor, who runs the gift shop, says, yes, she could send me to people "who want to go back to the '50s. But if we go back there, we'd be a dead town."

Rubashkin says his people have simply learned to fit in. They invite neighbors to their bar mitzvahs and have grown to appreciate a mowed lawn. "We don't look down on anybody. We share the same family values. And we learned the custom of saying 'hello.' You do that in New York and people think you're nuts."

Now that PETA has targeted AgriProcessors—a threat from true outsiders—the town has rallied round. The city council passed a resolution renouncing "unfounded and unproven attacks on AgriProcessors, Inc. or its kosher processing."

When I'd first asked Rubashkin for a tour of the slaughterhouse, he was wary, asking why I wanted to see it. I said that without it there wouldn't be much to Postville. "The locals don't want to hear that," he said ruefully. I said that's exactly what the locals had been telling me. For a man who rarely pauses, he did so for a second before replying, "Then things have really changed." □

TALKING KOSHER Find more Postville images and join a discussion about kosher practices at **nationalgeographic.com/magazine/0506**.

Cradling the youngest of his ten children, Sholom Rubashkin (above) wraps up business before the Jewish Sabbath (Shabbat) begins and all work must cease. When his father bought AgriProcessors, Rubashkin moved his family from Brooklyn to the Midwest. Younger members of Postville's Hasidim—including these women who cover their eyes in prayer to usher in Shabbat (below)—call this corner of Iowa home. And after 11 years, so does Sholom: "Until the Messiah comes," he says, "I'm staying right here."

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Final Edit

WEATHER FORECASTING

Hogging the Glory

When illustrations editor Kurt Mutchler and photographer Jay Dickman were exploring the many techniques for forecasting the weather, they couldn't ignore a sentimental favorite: Groundhog Day. Celebrated for more than a hundred years, the tradition lures thousands every February to Gobblers Knob in Punxsutawney, Pennsylvania, to watch Punxsutawney Phil (above) crawl into the light of day. If Phil sees his shadow, so the legend goes, six more weeks of winter lie ahead. Phil and his handler, shown in 2002, didn't make it into the story. "I was sorry to see our furry prognosticator go," says Kurt, "but we needed room for the hard, cold science of forecasting." But Jay is now a member of the Punxsutawney Groundhog Club. He was also the only photographer allowed onstage during the ceremony: "I wanted to get a rodent's-eye view of the crowd."

CUT IT OR KEEP IT? See the runner-up for Final Edit, in Departments at **nationalgeographic.com/magazine/0506**.

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CHESAPEAKE BAY (SEE PAGE 22)

PETER ESSICK, DAVE HARP PHOTOGRAPHY (CRAB)

GET INVOLVED

Save Your Wetlands

Wetlands can be found all over the U.S., from Alaska to Florida and points in between. Whether you live on Maryland's Patuxent River (above) or in Arkansas, you can help restore and protect wetlands, vital habitats that absorb floodwaters, filter pollution, and reduce erosion. *Chesapeakebay.net.helpbay.htm* offers ideas you can use to help wetlands in your area. You can also urge your local school to participate in Chesapeake Classrooms. This National Geographic Society-funded program helps teachers plan classes and activities that focus on environmental issues, especially those related to the bay. See *savethebay.org/edu/edu_tpd_landing.htm*.

GO BY SEA

Hey, Sailor

Follow in the wake of writer Tom Horton (right, at left) and Wade Murphy, Jr., at right, on the skipjack *Rebecca T. Ruark* by visiting some of the bay's best spots.

Tangier and Smith Islands Visit these hamlets still rooted in the waterman way of life. Ferries leave from Crisfield, Maryland, and Reedville, Virginia. For schedules, check out *smithisland.net* and *tangierisland-va.com*.

PETER ESSICK

Historic Chesapeake Lighthouses Tour a few of the more than 30 lighthouses that still grace bay waters. Don't miss Old Cape Henry in Virginia Beach, Virginia. Completed in 1792, this sandstone tower sits at the mouth of the Chesapeake and is the bay's oldest. See *baygateways.net/lighthouses.cfm* for more lighthouse lore.

PICKS

3 icons

Chesapeake Bay author **Tom Horton** reflects on his favorite bay symbols.

The skipjack and the bugeye Favored workboats of watermen, their sails once blossomed over the bay. Since the collapse of the commercial oyster fishery, the two-masted bugeye has been anchored in the past, but the simpler skipjack still sails.

Blue crab The sea-hued crustacean (above) is almost synonymous with the bay, and eating spiced, steamed crabs right out of the shell is a summertime tradition. But pollution, fishing, and degraded habitat have left crab populations near historic lows.

Great blue heron An elegant symbol of the bay, these birds inhabit the bay's entire watershed, from New York to Virginia. More than half of the Atlantic coast's breeding population nests in the bay's wetlands.

WEBSITE EXCLUSIVE

Zoom in on a photo gallery of the Chesapeake Bay at **nationalgeographic.com/magazine/0506**.

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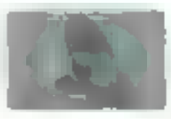

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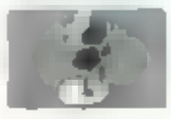

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PREVACID
(lansoprazole)
For Delayed-Release Oral Suspension

PREVACID SoluTab™
(lansoprazole)
Delayed-Release Orally Disintegrating Tablets

Rx only

Indications include: Short-Term Treatment (4 weeks) of Active Duodenal Ulcer. Maintenance of Healed Duodenal Ulcers, controlled studies do not extend beyond 12 months. **Short-Term Treatment (up to 8 weeks) of Active Benign Gastric Ulcer. Healing of NSAID-Associated Gastric Ulcer**, in patients who continue NSAID use. Controlled studies did not extend beyond 8 weeks. **Risk Reduction of NSAID-Associated Gastric Ulcer**, in patients with a history of documented gastric ulcer who require the use of an NSAID. Controlled studies did not extend beyond 12 weeks. **Gastroesophageal Reflux Disease (GERD).** Short-Term Treatment of Symptomatic GERD and Erosive Esophagitis (up to 8 weeks): for patients who do not heal with PREVACID for 8 weeks (5-10%), it may be helpful to give an additional 8 weeks of treatment. If there is a recurrence of erosive esophagitis, an additional 8-week course of PREVACID may be considered. **Maintenance of Healing of Erosive Esophagitis**, controlled studies did not extend beyond 36 months. **Pathological Hypersecretory Conditions including Zollinger-Ellison Syndrome**

CONTRAINDICATIONS
PREVACID is contraindicated in patients with known hypersensitivity to any component of the formulation of PREVACID.

PRECAUTIONS
General
Symptomatic response to therapy with lansoprazole does not preclude the presence of gastric malignancy.

Information for Patients
PREVACID is available as a capsule, orally disintegrating tablet and oral suspension, and is available in 15 mg and 30 mg strengths. Directions for use specific to the route and available methods of administration for each of these dosage forms is available in the complete prescribing information. PREVACID should be taken before eating. PREVACID products SHOULD NOT BE CRUSHED OR CHEWED.

Phenylketonurics: Contains Phenylalanine 2.5 mg per 15 mg Tablet and 5.1 mg per 30 mg Tablet.

Drug Interactions
Lansoprazole is metabolized through the cytochrome P_{450} system, specifically through the CYP3A and CYP2C19 enzymes. Studies have shown that lansoprazole does not have clinically significant interactions with other drugs metabolized by the cytochrome P_{450} system, such as warfarin, antipyrine, indomethacin, diazepam, phenytoin, propranolol, prednisone, diazepam, clarithromycin in healthy subjects. These compounds are metabolized through various cytochrome P_{450} enzymes, including CYP1A2, CYP2C9, CYP2C19, CYP2D6, and CYP3A. When lansoprazole was administered concomitantly with theophylline (CYP1A2, CYP3A), a minor decrease (10%) in the clearance of theophylline was seen. Because of the small magnitude and the direction of the effect on theophylline clearance, this interaction is unlikely to be of clinical concern. Nonetheless, individual patients may require additional titration of their theophylline dosage when lansoprazole is started or stopped to ensure clinically effective blood levels.

In a study of healthy subjects, neither the pharmacokinetics of warfarin enantiomers nor prothrombin time were affected following single or multiple 60 mg doses of lansoprazole. However, there have been reports of increased International Normalized Ratio (INR) and prothrombin time in patients receiving proton pump inhibitors, including lansoprazole, and warfarin concomitantly. Increases in INR and prothrombin time may lead to abnormal bleeding and even death. Patients treated with proton pump inhibitors and warfarin concomitantly may need to be monitored for increases in INR and prothrombin time.

Lansoprazole has also been shown to have no clinically significant interaction with antacids. In a single-dose crossover study examining lansoprazole 30 mg and omeprazole 20 mg each administered alone and concomitantly with sucralfate 1 gram, absorption of the proton pump inhibitors was delayed and their bioavailability was reduced by 17% and 16%, respectively, when administered concomitantly with sucralfate. Therefore, proton pump inhibitors should be taken at least 30 minutes prior to sucralfate. In clinical trials, antacids were administered concomitantly with PREVACID Delayed-Release Capsules. This did not interfere with its effect.

Lansoprazole causes a profound and long-lasting inhibition of gastric acid secretion. Therefore, it is theoretically possible that lansoprazole may interfere with the absorption of drugs where gastric pH is an important determinant of bioavailability (e.g., ketoconazole, ampicillin esters, iron salts, digoxin).

Carcinogenesis, Mutagenesis, Impairment of Fertility
In two 24-month carcinogenicity studies, Sprague-Dawley rats were treated orally with doses of 5 to 150 mg/kg/day, about 1 to 40 times the exposure on a body surface (mg/m²) basis of a 50-kg person of average height (1.46 m² body surface area) given the recommended human dose of 30 mg/day (22.2 mg/m²). Lansoprazole produced dose-related gastric enterochromaffin-like (ECL) cell hyperplasia and ECL cell carcinoids in both male and female rats. It also increased the incidence of intestinal metaplasia of the gastric epithelium in both sexes in male rats. Lansoprazole produced a dose-related increase of testicular interstitial cell adenomas. The incidence of these adenomas in rats receiving doses of 15 to 150 mg/kg/day (4 to 40 times the recommended human dose based on body surface area) exceeded the low background incidence (range = 1.4 to 10%) for this strain of rat. Testicular interstitial cell adenoma also occurred in 1 of 30 rats treated with 50 mg/kg/day (13 times the recommended human dose based on body surface area) in a 1-year toxicity study.

In a 24-month carcinogenicity study, CD-1 mice were treated orally with doses of 15 to 600 mg/kg/day, 2 to 80 times the recommended human dose based on body surface area. Lansoprazole produced a dose-related increased incidence of gastric ECL cell hyperplasia and also produced an increased incidence of liver tumors (hepatocellular adenoma plus carcinoma). The tumor incidences in male mice treated with 300 and 600 mg/kg/day (40 to 80 times the recommended human dose based on body surface area) and female mice (entire study) with 150 to 600 mg/kg/day (20 to 80 times the recommended human dose based on body surface area) exceeded the ranges of background incidences in historical controls for this strain of mice. Lansoprazole treatment produced adenoma of rete testis in male mice receiving 75 to 600 mg/kg/day (10 to 80 times the recommended human dose based on body surface area).

Lansoprazole was not genotoxic in the Ames test, the in vitro rat hepatocyte unscheduled DNA synthesis (UDS) test, the in vivo mouse micronucleus test or the rat bone marrow cell chromosomal aberration test. It was positive in an in vitro human lymphocyte chromosomal aberration assays.

Lansoprazole at oral doses up to 150 mg/kg/day (40 times the recommended human dose based on body surface area) was found to have no effect on fertility and reproductive performance of male and female rats.

Pregnancy, Teratogenic Effects
Pregnancy Category B

Lansoprazole
Teratology studies have been performed in pregnant rats at oral doses up to 150 mg/kg/day (40 times the recommended human dose based on body surface area) and pregnant rabbits at oral doses up to 30 mg/kg/day (16 times the recommended human dose based on body surface area) and have revealed no evidence of impaired fertility or harm to the fetus due to lansoprazole.

There are, however, no adequate or well-controlled studies in pregnant women. Because animal reproduction studies are not always predictive of human response, this drug should be used during pregnancy only if clearly needed.

Nursing Mothers
Lansoprazole or its metabolites are excreted in the milk of rats. It is not known whether lansoprazole is excreted in human milk. Because many drugs are excreted in human milk, because of the potential for serious adverse reactions in nursing infants from lansoprazole, and because of the potential for tumorigenicity shown for lansoprazole in rat carcinogenicity studies, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother.

Pediatric Use
The safety and effectiveness of PREVACID have been established in pediatric patients 1 to 17 years of age for short-term treatment of symptomatic GERD and erosive esophagitis. Use of PREVACID in this population is supported by evidence from adequate and well-controlled studies of PREVACID in adults with additional clinical, pharmacokinetic, and pharmacodynamic studies performed in pediatric patients. The adverse events profile in pediatric patients is similar to that of adults. There were no adverse events reported in U.S. clinical studies that were not previously observed in adults. The safety and effectiveness of PREVACID in patients <1 year

pl age have not been established.

1 to 11 years of age

The pediatric safety of PREVACID Delayed-Release Capsules has been assessed in 66 pediatric patients aged 1 to 11 years of age. Of the 66 patients with GERD 85% (56/66) took PREVACID for 8 weeks and 15% (10/66) took it for 12 weeks.

The most frequently reported (2 or more patients) treatment-related adverse events in patients 1 to 11 years of age (N=66) were constipation (5%) and headache (3%).

12 to 17 years of age

The safety of PREVACID Delayed-Release Capsules has been assessed in these 87 adolescent patients. Of the 87 adolescent patients with GERD, 6% (5/87) took PREVACID for <8 weeks, 93% (81/87) for 8-10 weeks, and 1% (1/87) for >10 weeks.

The most frequently reported (at least 3%) treatment-related adverse events in these patients were headache (7%), abdominal pain (5%), nausea (3%) and dizziness (3%). Treatment-related dizziness, reported in this package insert as occurring in <1% of adult patients, was reported in this study by 3 adolescent patients with nonerosive GERD, who had dizziness concurrently with other events (such as migraine, dyspnea, and vomiting).

Use in Women

Over 4,000 women were treated with lansoprazole. Ulcer healing rates in females were similar to those in males. The incidence rates of adverse events were also similar to those seen in males.

Use in Geriatric Patients

Ulcer healing rates in elderly patients are similar to those in a younger age group. The incidence rates of adverse events and laboratory test abnormalities are also similar to those seen in younger patients. For elderly patients, dosage and administration of lansoprazole need not be altered for a particular indication.

ADVERSE REACTIONS

Clinical

Worldwide, over 10,000 patients have been treated with lansoprazole in Phase 2-3 clinical trials involving various dosages and durations of treatment. The adverse reaction profiles for PREVACID Delayed-Release Capsules and PREVACID for Delayed-Release Oral Suspension are similar. In general, lansoprazole treatment has been well-tolerated in both short-term and long-term trials.

The following adverse events were reported by the treating physician to have a possible or probable relationship to drug in 1% or more of PREVACID-treated patients and occurred at a greater rate in PREVACID-treated patients than placebo-treated patients. The incidence of the most common possibly or probably treatment-related adverse events with PREVACID in short-term, placebo-controlled studies were abdominal pain (2.1%), constipation (1.0%), diarrhea (3.8%), and nausea (1.3%). Results for placebo were 1.2%, 0.4%, 2.3%, and 1.2% respectively.

Headache was also seen at greater than 1% incidence but was more common on placebo. The incidence of diarrhea was similar between patients who received placebo and patients who received lansoprazole 15 mg and 30 mg, but higher in the patients who received lansoprazole 60 mg (2.9%, 1.4%, 4.2%, and 7.4%, respectively).

The most commonly reported possibly or probably treatment-related adverse event during maintenance therapy was diarrhea.

In the risk reduction study of PREVACID for NSAID-associated gastric ulcers, the incidence of diarrhea for patients treated with PREVACID was 5%, misoprostol 22%, and placebo 3%.

Additional adverse experiences occurring at <1% in patients or subjects in domestic trials are shown below. Refer to **Postmarketing** for adverse reactions occurring since the drug was marketed.

Body as a Whole - abdomen enlarged, allergic reaction, asthenia, back pain, candidiasis, carcinoma, chest pain (not otherwise specified), chills, edema, fever, flu syndrome, halitosis, infection (not otherwise specified), malaise, neck pain, neck rigidity, pain, pelvic pain; *Cardiovascular System* - angina, arrhythmia, bradycardia, cerebrovascular accident/cerebral infarction, hypertension/hypotension, migraine, myocardial infarction, palpitations, shock (circulatory failure), syncope, tachycardia, vasodilation; *Digestive System* - abnormal stools, anorexia, benign cardiospasm, cholelithiasis, colitis, dry mouth, dyspepsia, dysphagia, enteritis, eructation, esophageal stenosis, esophageal ulcer, esophagitis, focal discoloration, flatulence, gastric nodules/fundic gland polyps, gastritis, gastroenteritis, gastrointestinal anomaly, gastrointestinal disorder, gastrointestinal hemorrhage, glossitis, gum hemorrhage, hematemesis, increased appetite, increased salivation, melena, mouth ulceration, nausea and vomiting, nausea and vomiting and diarrhea, oral moniliasis, rectal disorder, rectal hemorrhage, stomatitis, tenesmus, thirst, tongue disorder, ulcerative colitis, ulcerative stomatitis; *Endocrine System* - diabetes mellitus, goiter, hypothyroidism; *Hemic and Lymphatic System* - anemia, hemolysis, lymphadenopathy; *Metabolic and Nutritional Disorders* - gout, dehydration, hyperglycemia/hypoglycemia, peripheral edema, weight gain/loss; *Musculoskeletal System* - arthralgia, arthritis, bone disorder, joint disorder, leg cramps, musculoskeletal pain, myalgia, myasthenia, synovitis; *Nervous System* - abnormal dreams, agitation, amnesia, anxiety, apathy, confusion, convulsion, depersonalization, depression, diplopia, dizziness, emotional lability, hallucinations, hemiplegia, hostility aggravated, hyperkinesia, hypertonia, hypesthesia, insomnia, libido decreased/increased, nervousness, neurosis, paresthesia, sleep disorder, somnolence, thinking abnormality, tremor, vertigo; *Respiratory System* - asthma, bronchitis, cough increased, dyspnea, epistaxis, hemoptysis, hiccup, laryngeal neoplasia, pharyngitis, pleural disorder, pneumonia, respiratory disorder, upper respiratory inflammation/infection, rhinitis, sinusitis, stridor; *Skin and Appendages* - acne, alopecia, contact dermatitis, dry skin, fixed eruption, hair disorder, maculopapular rash, nail disorder, pruritus, rash, skin carcinoma, skin disorder, sweating, urticaria; *Special Senses* - abnormal vision, blurred vision, conjunctivitis, deafness, dry eyes, ear disorder, eye pain, otitis media, parosmia, photophobia, retinal degeneration, taste loss, taste perversion, tinnitus, visual field defect; *Urogenital System* - abnormal menses, breast enlargement, breast pain, breast tenderness, dysmenorrhea, dysuria, gynecomastia, impotence, kidney calculus, kidney pain, leukorrhea, menorrhagia, menstrual disorder, penis disorder, polyuria, testis disorder, urethral pain, urinary frequency, urinary tract infection, urinary urgency, urination impaired, vaginitis.

Postmarketing

On-going Safety Surveillance: Additional adverse experiences have been reported since lansoprazole has been marketed. The majority of these cases are foreign-sourced and a relationship to lansoprazole has not been established. Because these events were reported voluntarily from a population of unknown size, estimates of frequency cannot be made. These events are listed below by COSTART body system.

Body as a Whole - anaphylaxis-like reaction; *Digestive System* - hepatotoxicity, pancreatitis, vomiting; *Hemic and Lymphatic System* - agranulocytosis, aplastic anemia, hemolytic anemia, leukopenia, neutropenia, pancytopenia, thrombocytopenia, and thrombotic thrombocytopenic purpura; *Skin and Appendages* - severe dermatologic reactions including erythema multiforme, Stevens-Johnson syndrome, toxic epidermal necrolysis (some fatal); *Special Senses* - speech disorder; *Urogenital System* - urinary retention.

Laboratory Values

The following changes in laboratory parameters for lansoprazole were reported as adverse events:

Abnormal liver function tests, increased SGOT (AST), increased SGPT (ALT), increased creatinine, increased alkaline phosphatase, increased globulins, increased GGTP, increased/decreased/abnormal WBC, abnormal AG ratio, abnormal RBC, bilirubinemia, eosinophilia, hyperlipemia, increased/decreased electrolytes, increased/decreased cholesterol, increased glucocorticoids, increased LDH, increased/decreased/abnormal platelets, and increased gastrin levels. Urine abnormalities such as albuminuria, glycosuria, and hematuria were also reported. Additional isolated laboratory abnormalities were reported.

In the placebo controlled studies, when SGOT (AST) and SGPT (ALT) were evaluated, 0.4% (4/978) placebo patients and 0.4% (11/2677) lansoprazole patients had enzyme elevations greater than three times the upper limit of normal range at the final treatment visit. None of these lansoprazole patients reported jaundice at any time during the study.

OVERDOSAGE

Oral doses up to 5000 mg/kg in rats (approximately 1300 times the recommended human dose based on body surface area) and mice (about 675.7 times the recommended human dose based on body surface area) did not produce deaths or any clinical signs.

Lansoprazole is not removed from the circulation by hemodialysis. In one reported case of overdose, the patient consumed 600 mg of lansoprazole with no adverse reaction.

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For more detailed information, see full prescribing information or contact TAP Medical Information at 1-800-622-2011.

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Acid reflux disease can affect people differently. Some have a chronic cough, others regurgitate frequently. But whether you're 12 months old or a senior, Prevacid® can help. It can be taken in many forms — one that's a pill, one you can drink, and one that disintegrates in your mouth — to help treat heartburn and many other kinds of symptoms related to acid reflux disease in many kinds of people. So ask your doctor about Prevacid today.

Put it to your acid test.

For a FREE trial certificate, call 1-888-PREVACID or visit prevacid.com today.

Important Information: Prevacid is used to treat acid reflux disease in children ages 1 to 17 years old. Individual results may vary. The most frequently reported side effects in children 1–11 years old were constipation and headache, and in adolescents 12–17 years old were headache, abdominal pain, nausea, and dizziness. See adult side effects and additional important information at far left, and talk to your child's doctor.

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Flashback

ALFRED PALMER

WEATHER FORECASTING

Tress Test

Every day in 1943 was a good hair day for this young woman—no matter what her own hair looked like. Part of her job at the Washington Institute of Technology was to evaluate shiny, severed ponytails of human hair. Strands from them were the main component in hygrometers. Those humidity monitors gauged atmospheric moisture by how much the hair strands lengthened or shortened.

Not just any hair would do. According to this photo's notes, many of the locks came "from northern Midwestern states where Scandinavian blood predominates. A good hank of blond hair usually brings about $25." —*Margaret G. Zackowitz*

FLASHBACK PHOTOS Access the archive, send e-greetings: in Departments at **nationalgeographic.com/magazine/0506.**

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HONDA

The Accord V-6 Sedan

honda.com 1-800-33-Honda *National Highway Traffic Safety Administration frontal crash test: February 2003. EX V-6 model shown.